

# Assessing, modeling and predicting short and long term coastal change for Ocean Beach and the mouth of San Francisco Bay

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# Project Goal

Determine the cause of the erosional hot spot in the southern portion of Ocean Beach

# Ocean Beach Erosion- near Sloat

1979



1987



1998



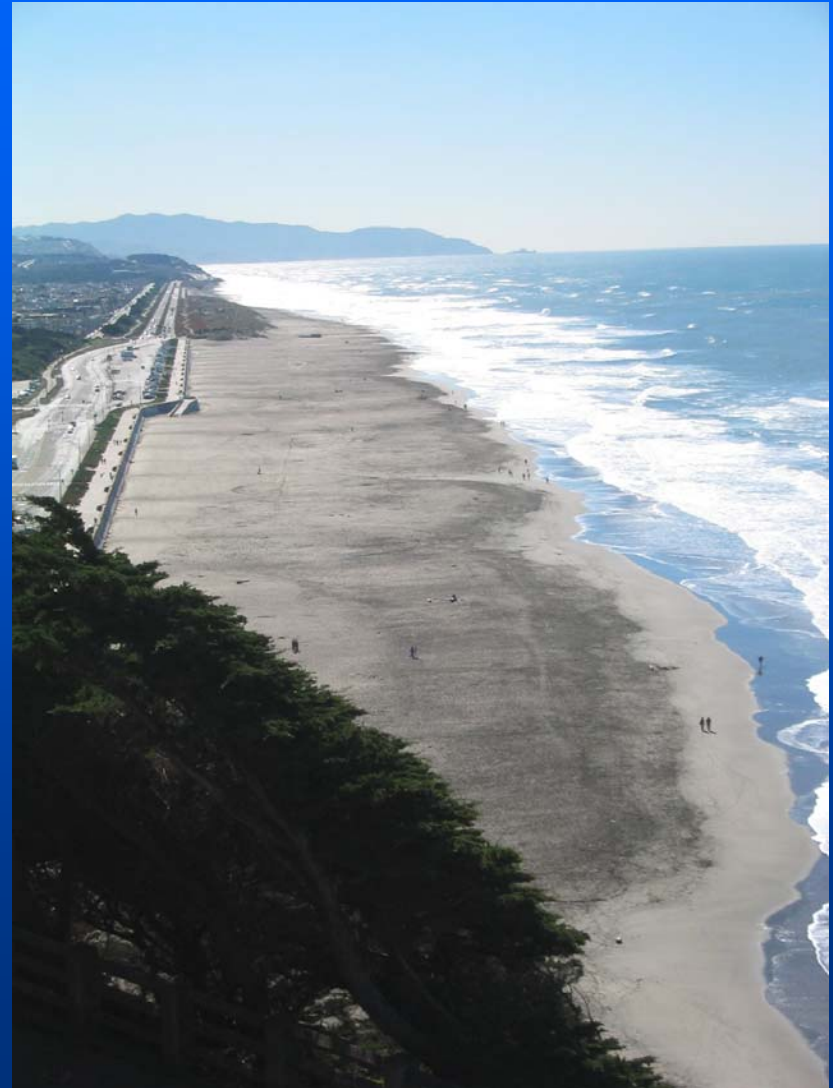
2003





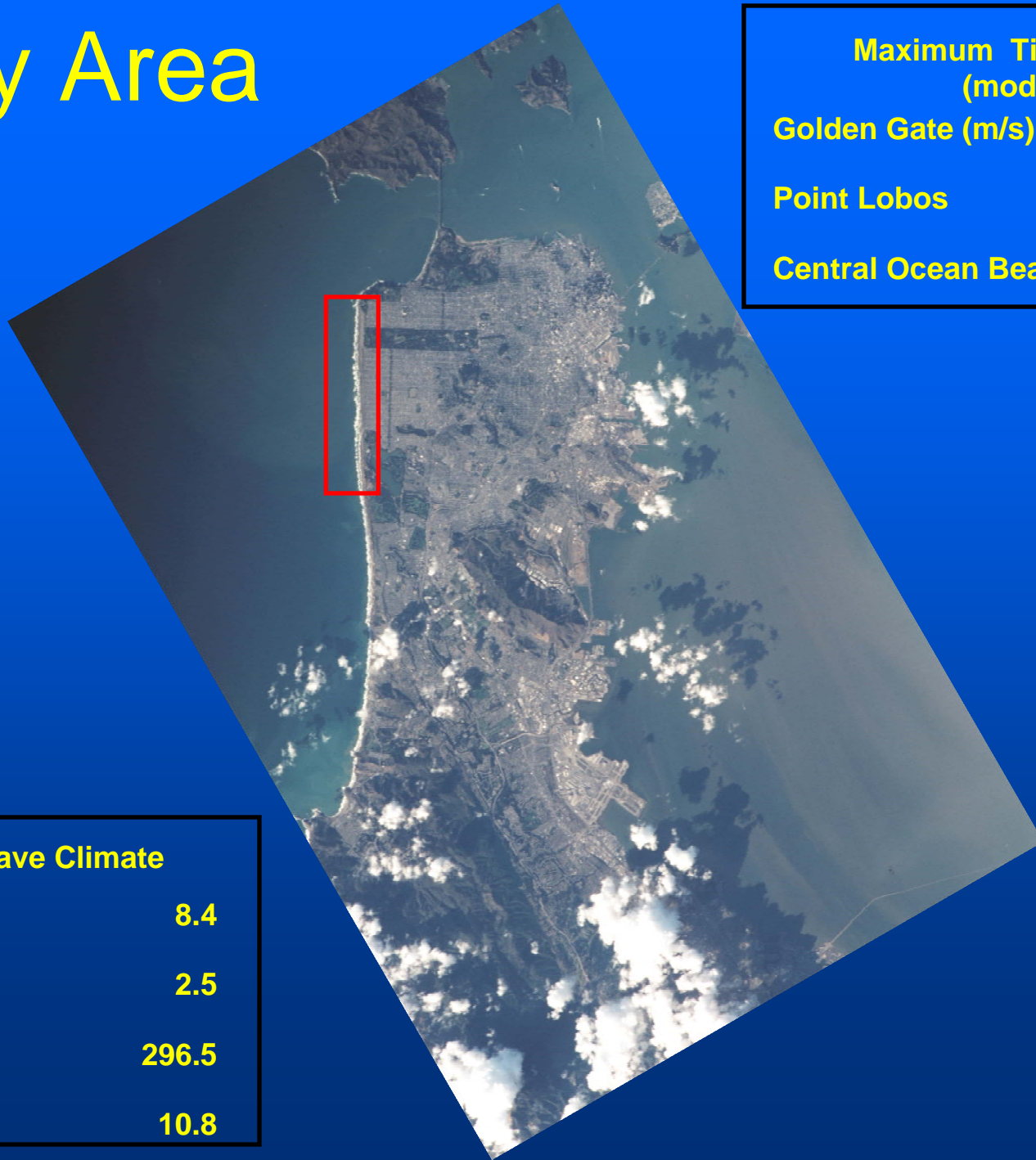
# Project Summary

- USGS Support: Mendenhall Post-doctoral Fellowship, Coastal Evolution Modeling
- Collaborating Agencies: National Park Service, City of San Francisco, U.S. Army Corps of Engineers (San Francisco District), California Boating and Waterways (pending), extensive student involvement from UC Santa Cruz, San Francisco State and Cal State Monterey Bay
- Models used: Delft3D (with SWAN) and NearCom





# Study Area



## Maximum Tidal Currents (modeled)

Golden Gate (m/s)	2.5
Point Lobos	1.5
Central Ocean Beach	1.0

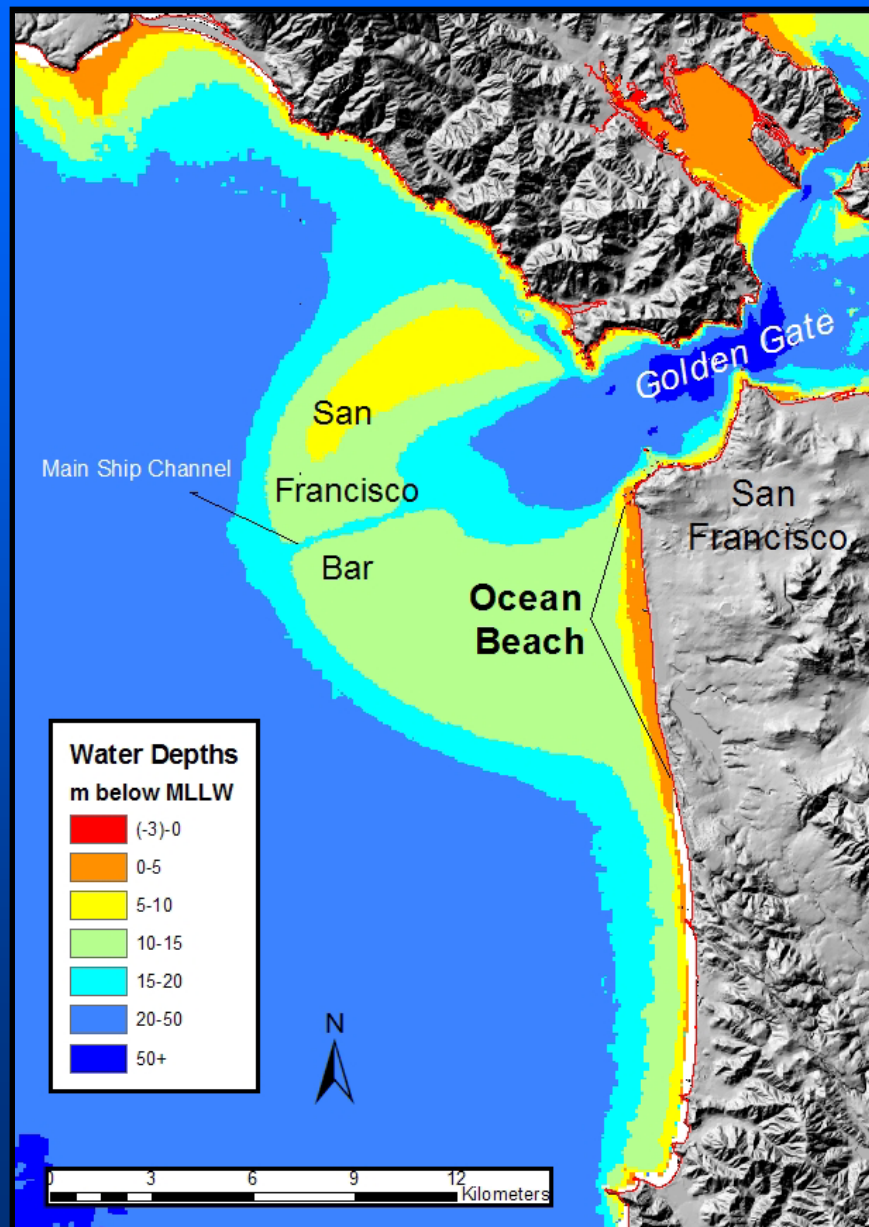
## Offshore Wave Climate

max Hs (m)	8.4
avg Hs (m)	2.5
avg deg (naut)	296.5
avg Tp (s)	10.8

# Ocean Beach



# Study Area



- Hypothesis #1: The ebb tidal delta has shrunk in extent due to a reduced tidal prism—thereby altering wave refraction/focusing patterns and sediment transport pathways.
- Hypothesis #2: The system is sediment starved due to extensive damming coupled with a significant decrease in delta discharge.

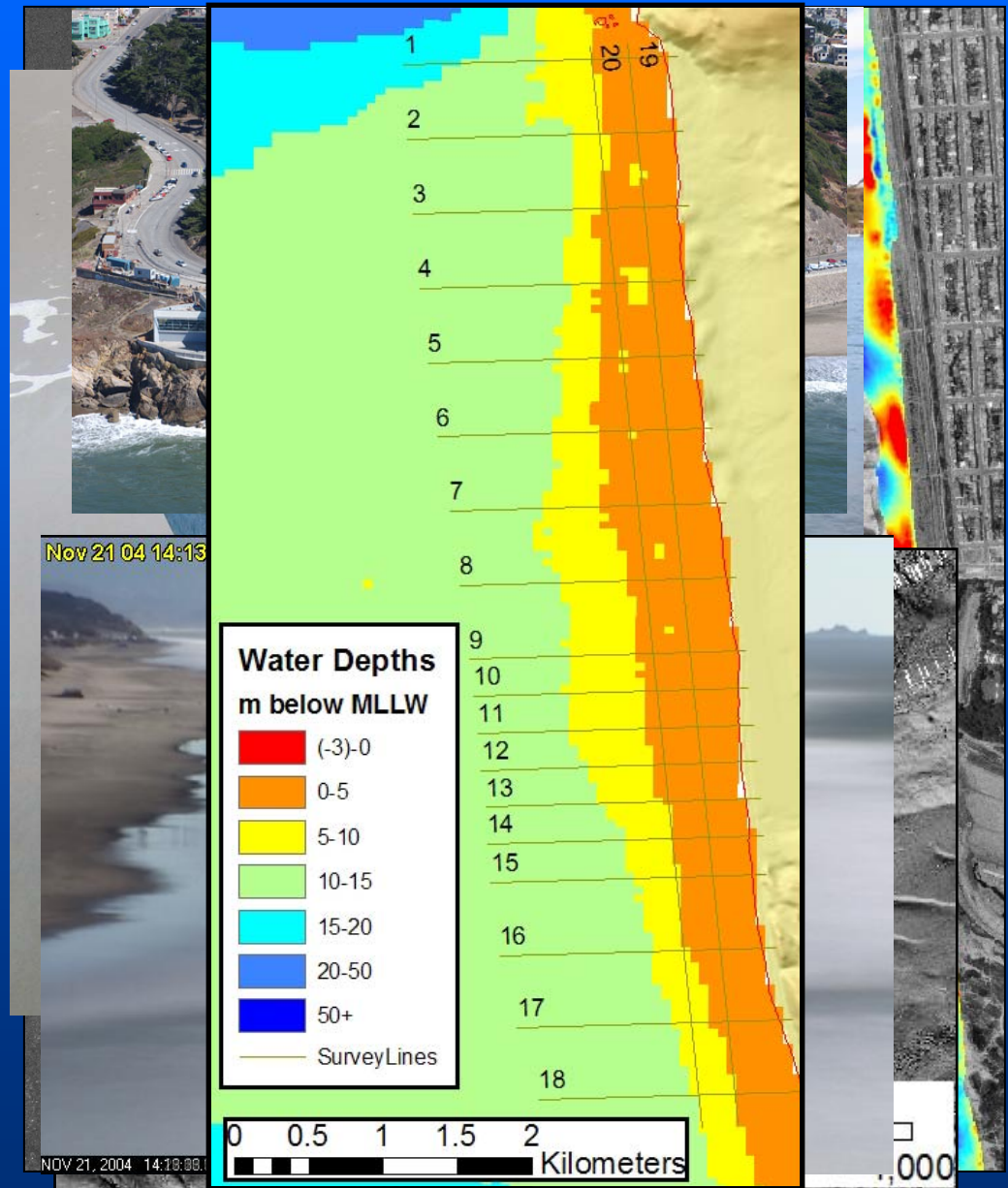


# Objectives

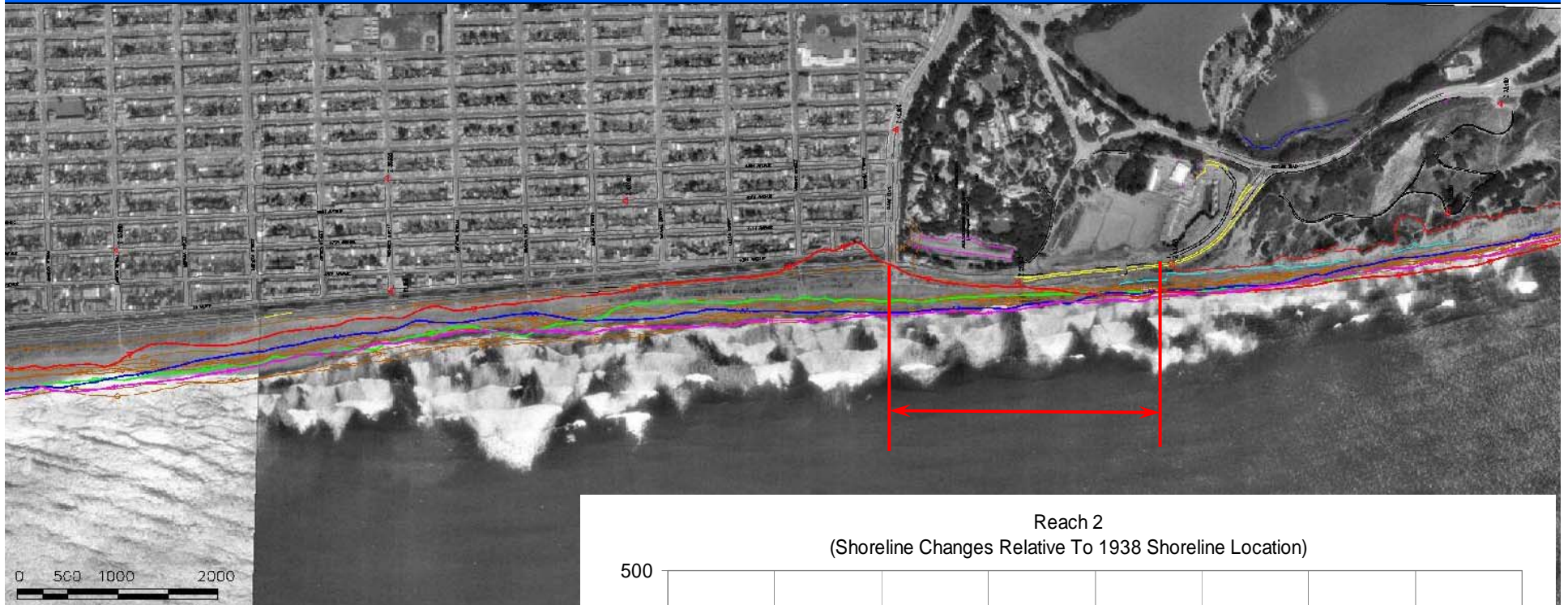
- Determine the cause of the erosional hot spot in the southern portion of Ocean Beach
- Quantify the physical processes impacting Ocean Beach
- Develop a sediment transport model for the mouth of San Francisco Bay
- Evaluate sediment management options
- Model potential solutions

# Field Support

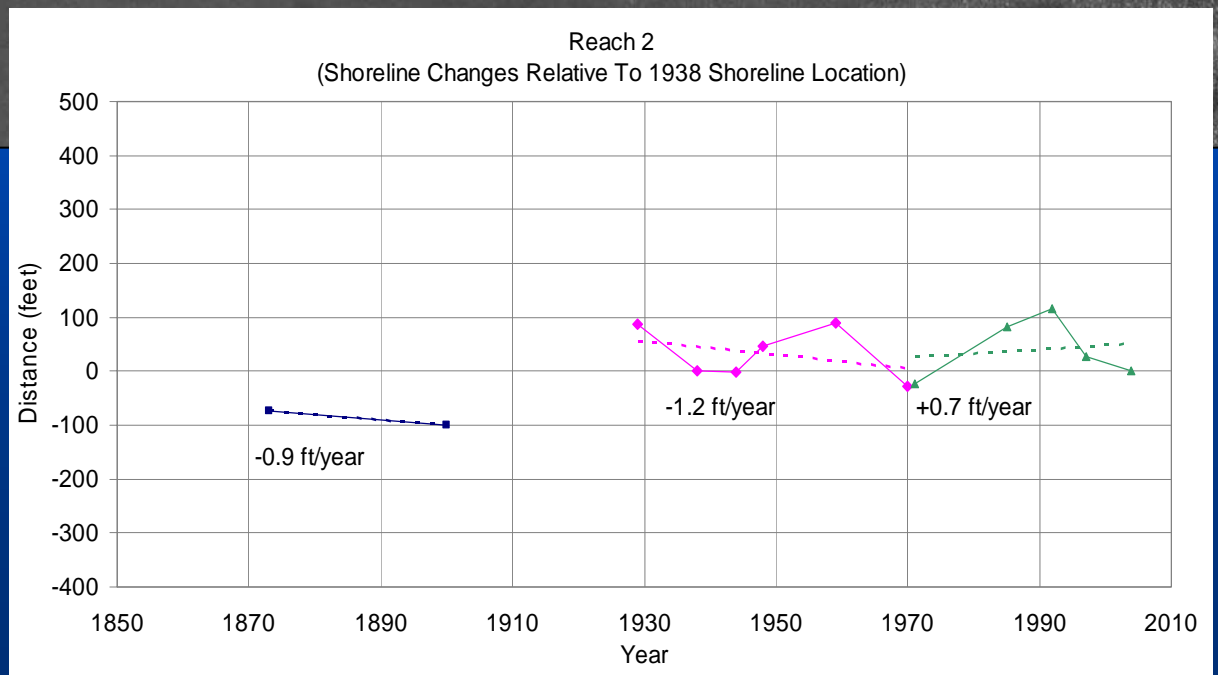
- All-terrain vehicle beach surveys



# Shoreline Changes at Ocean Beach

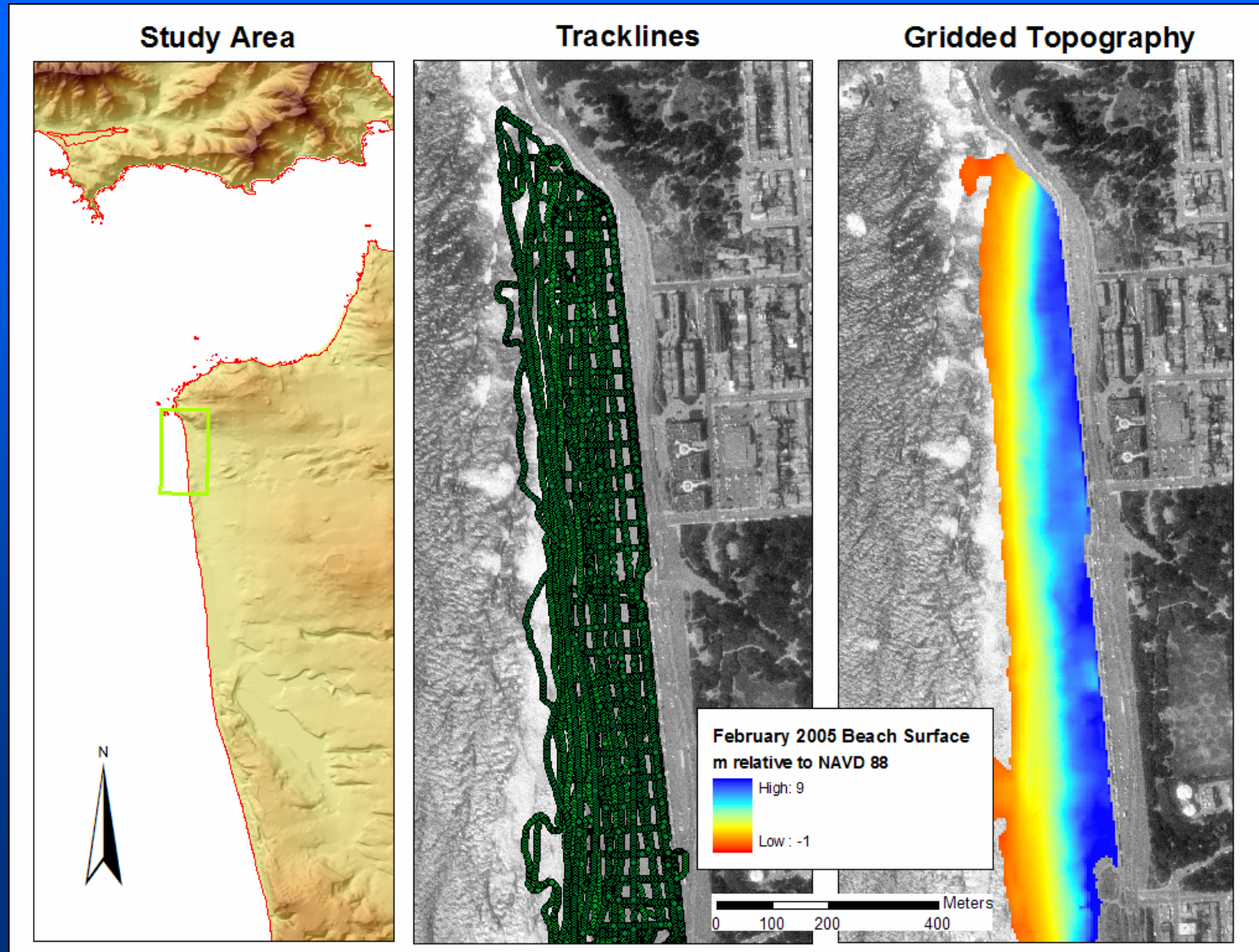


- 1873 shoreline
- 1938 shoreline
- 1985 shoreline
- 1992 shoreline

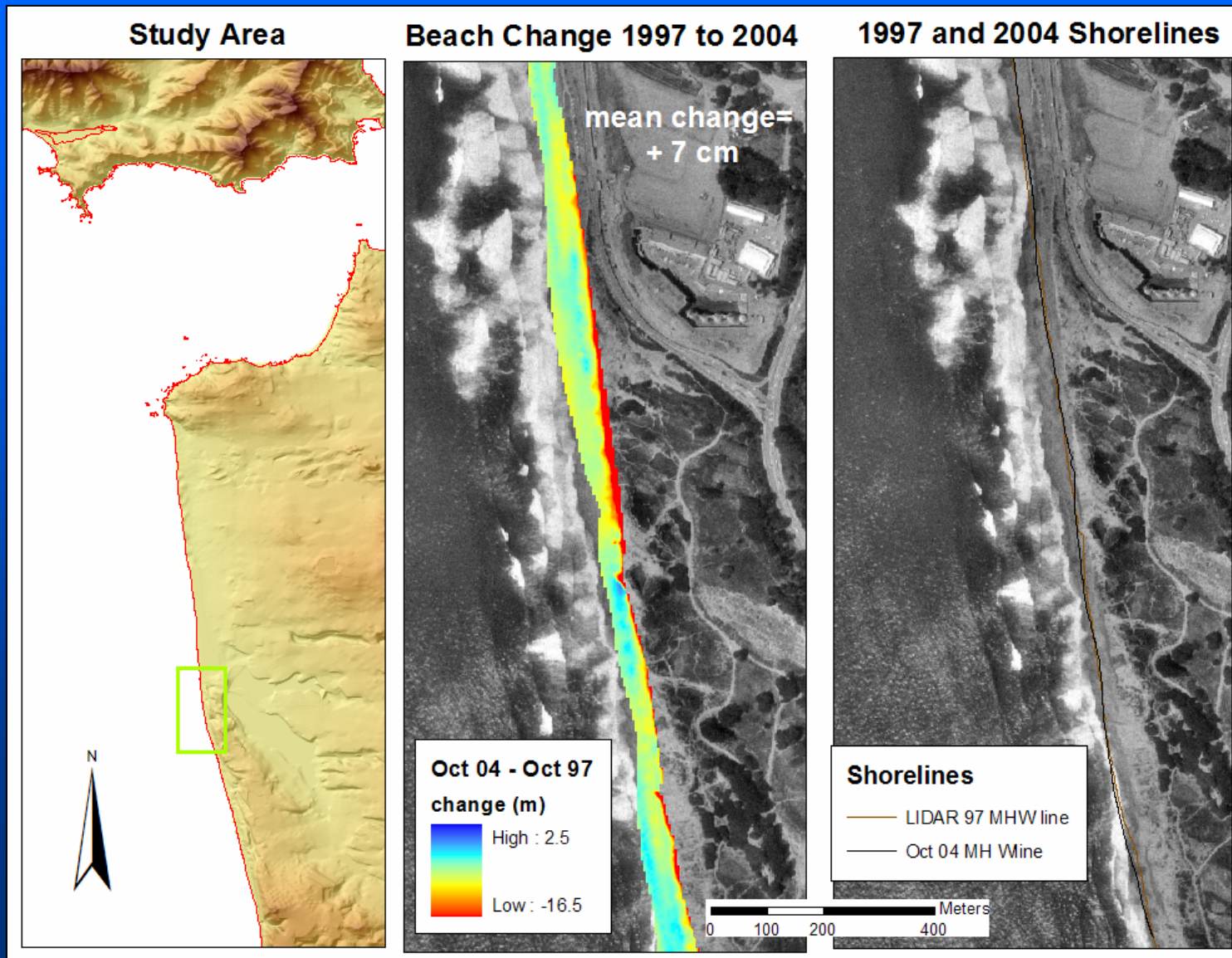




# Beach Mapping

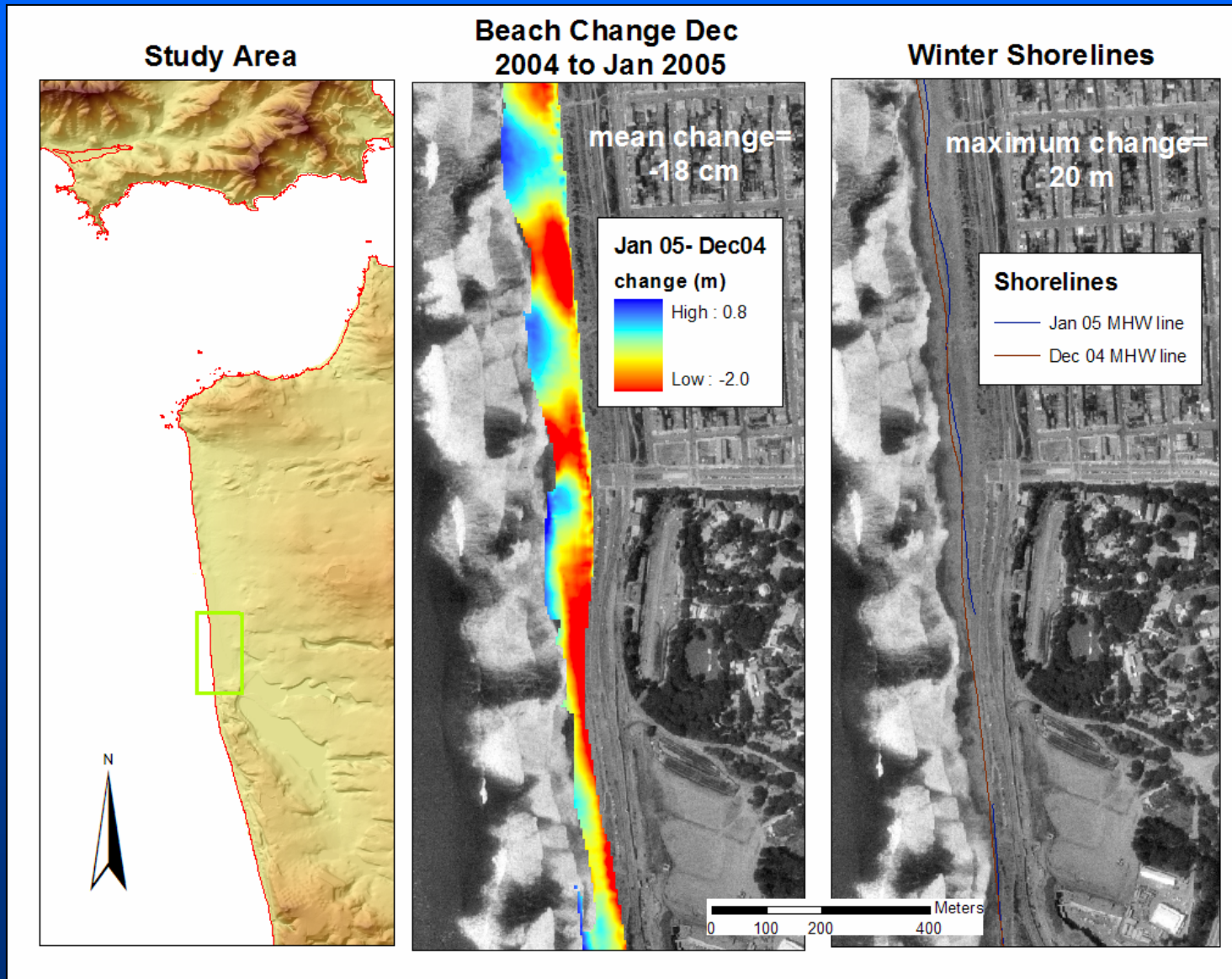


# Beach Mapping



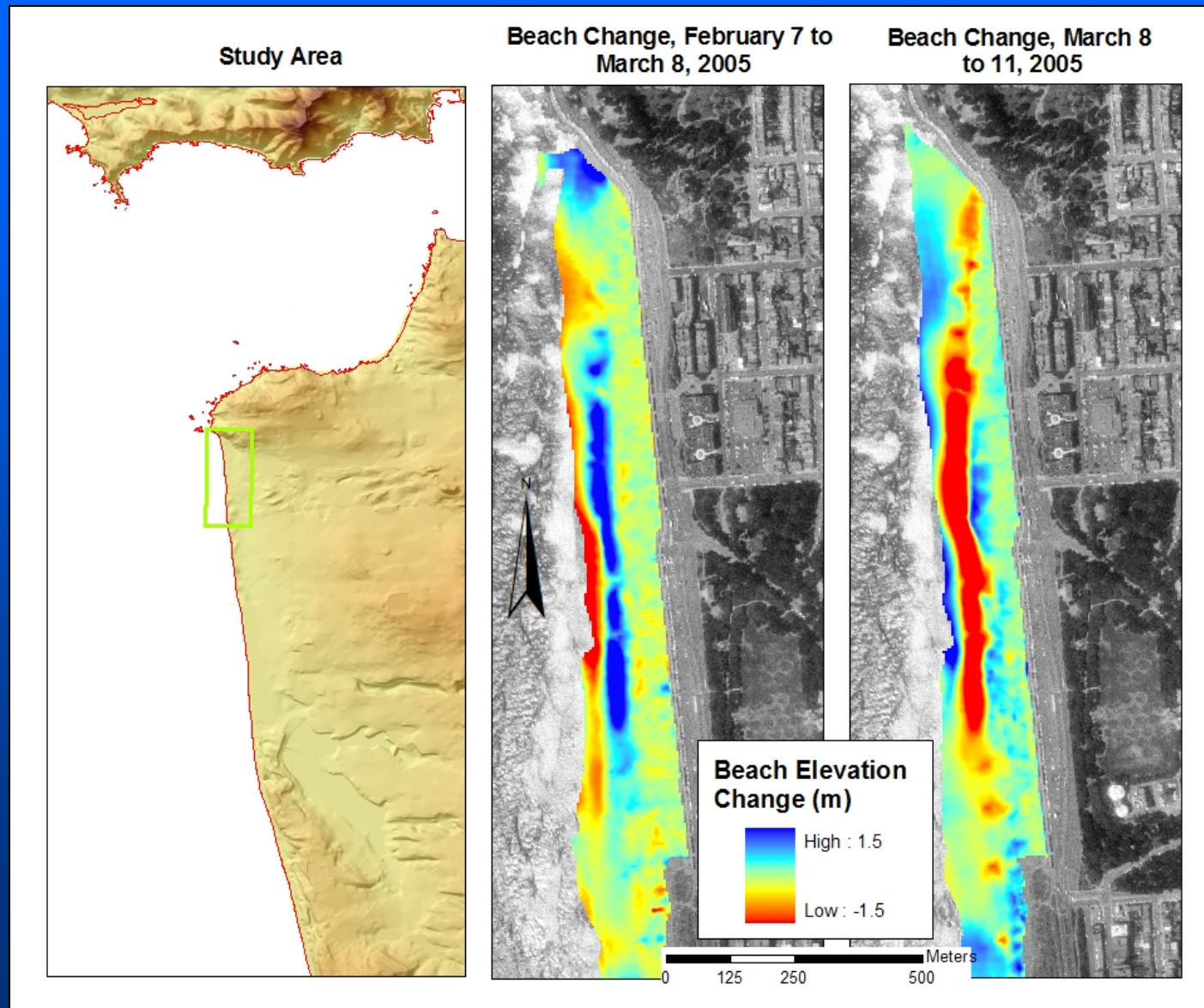


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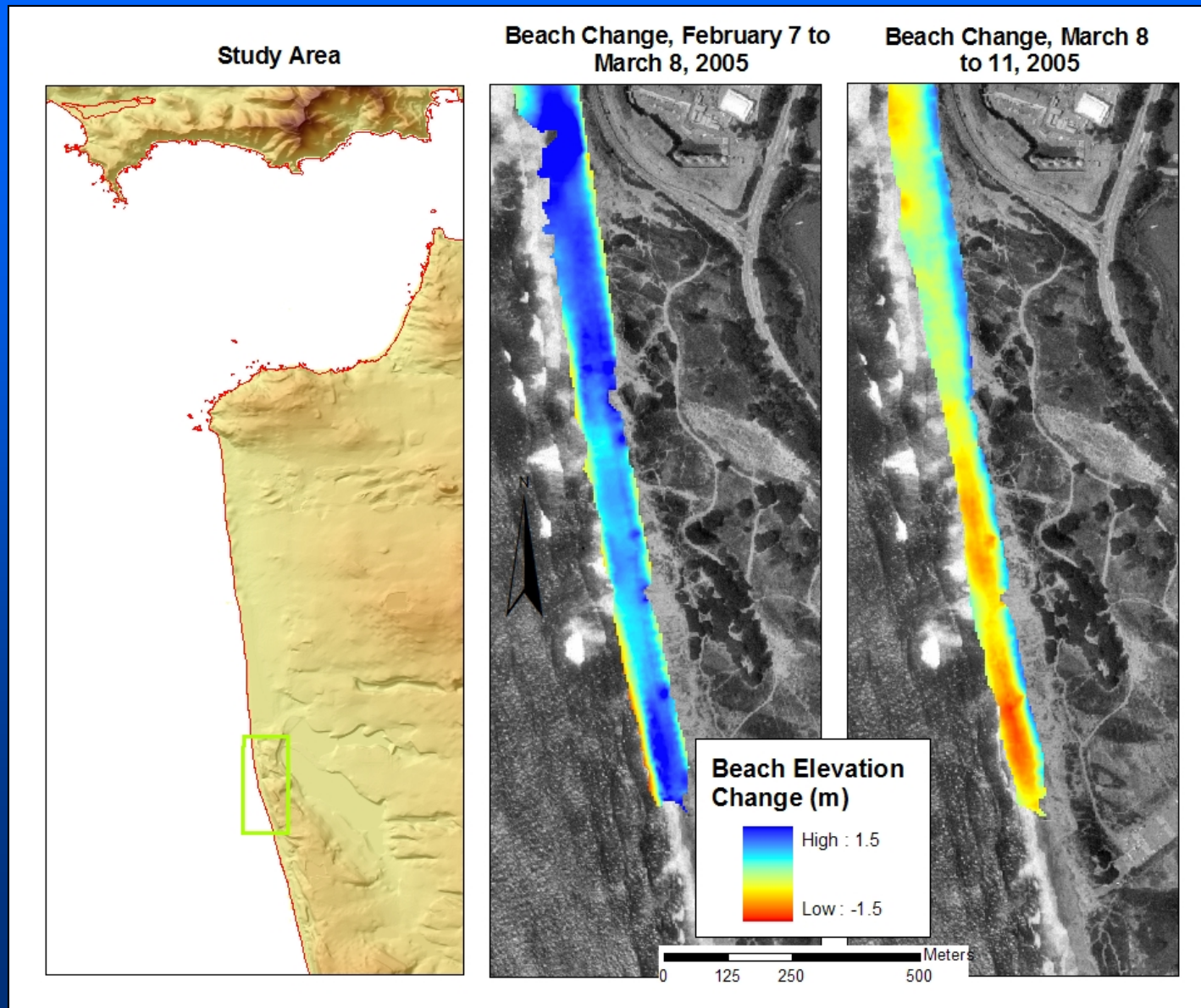




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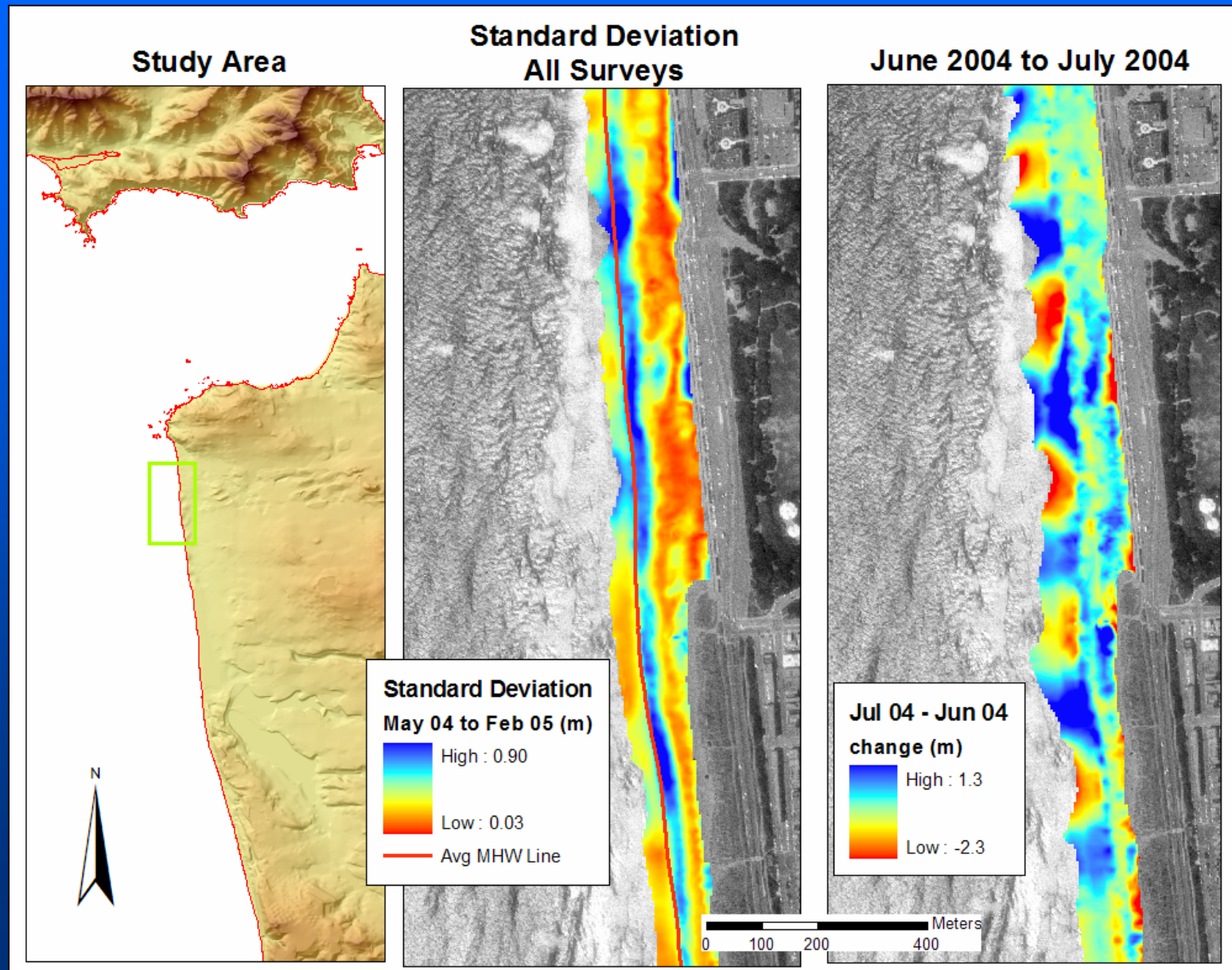


# Beach Mapping



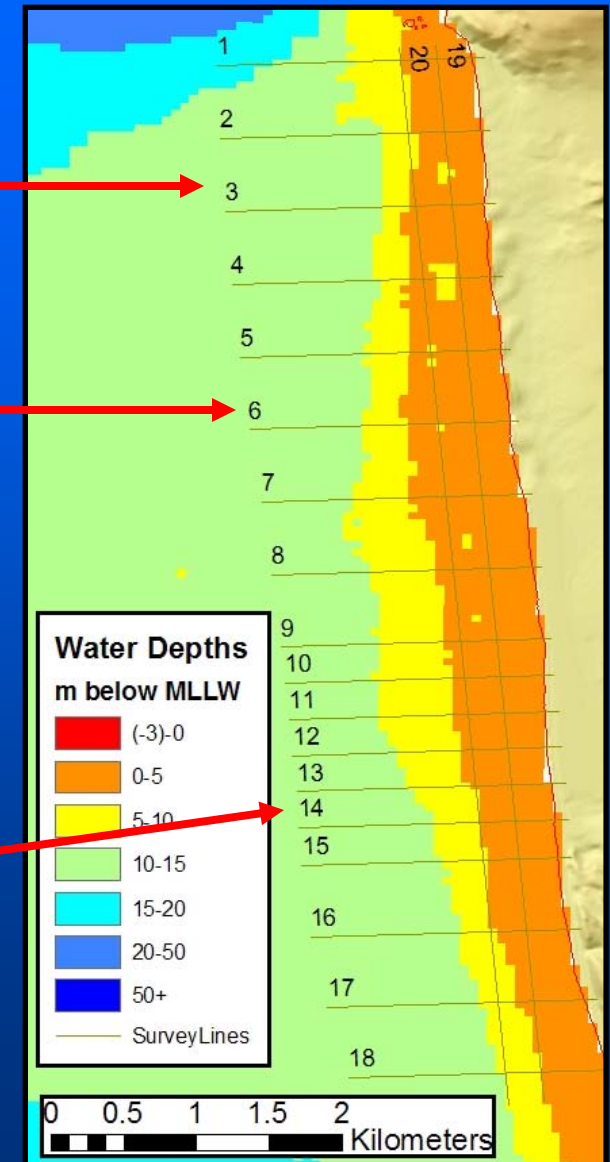
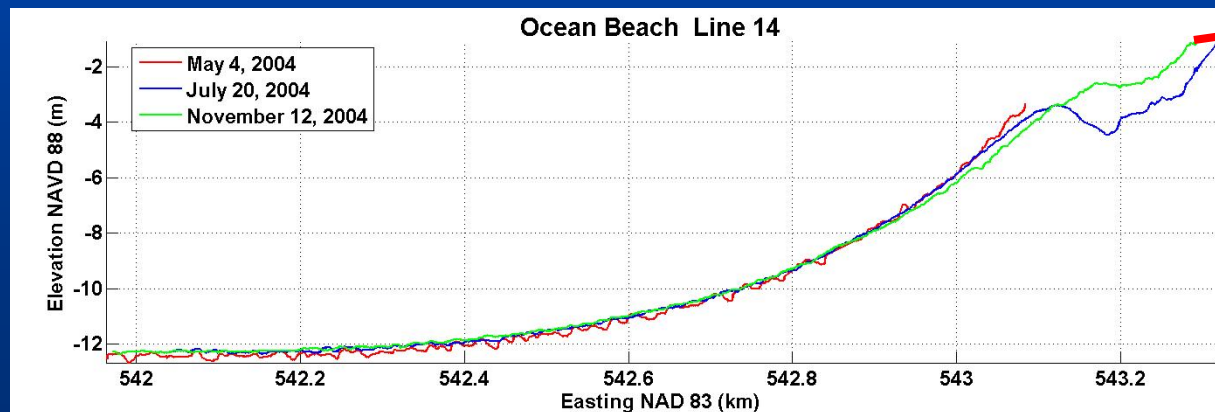
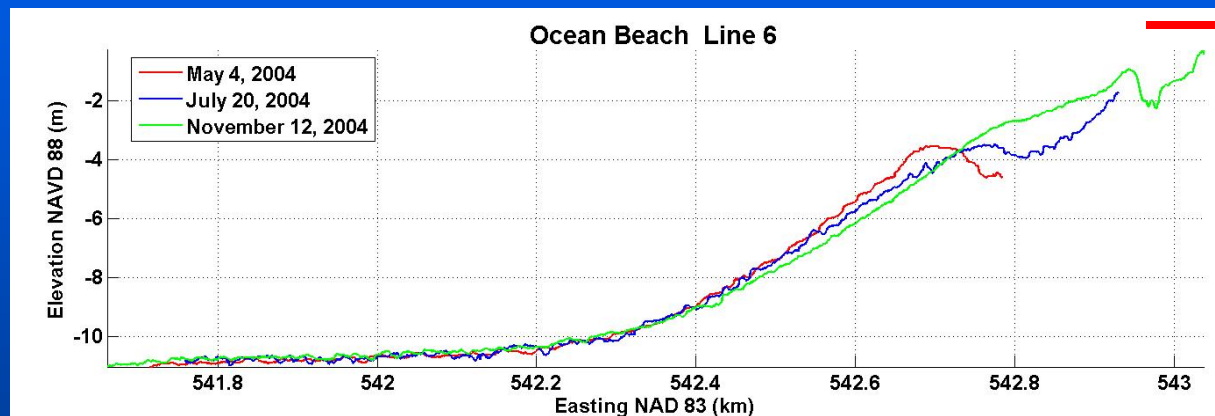
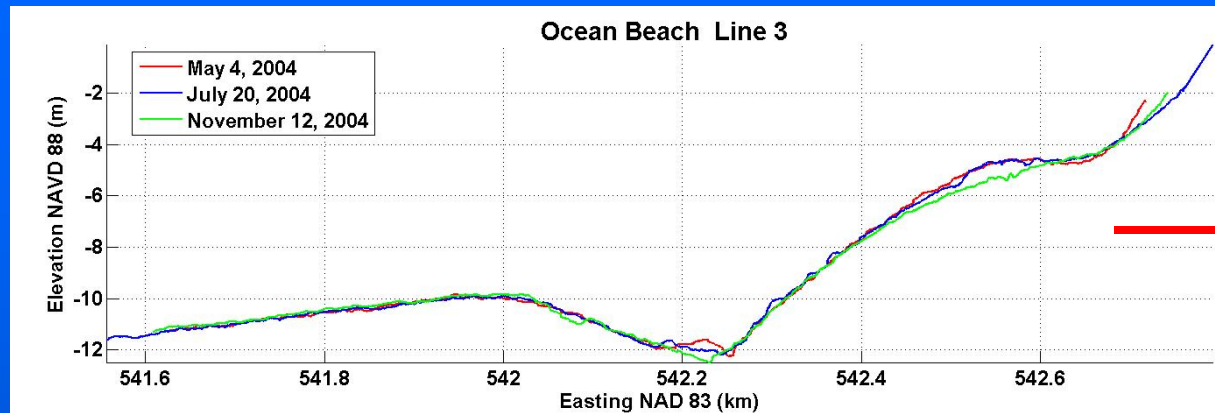


# Beach Mapping

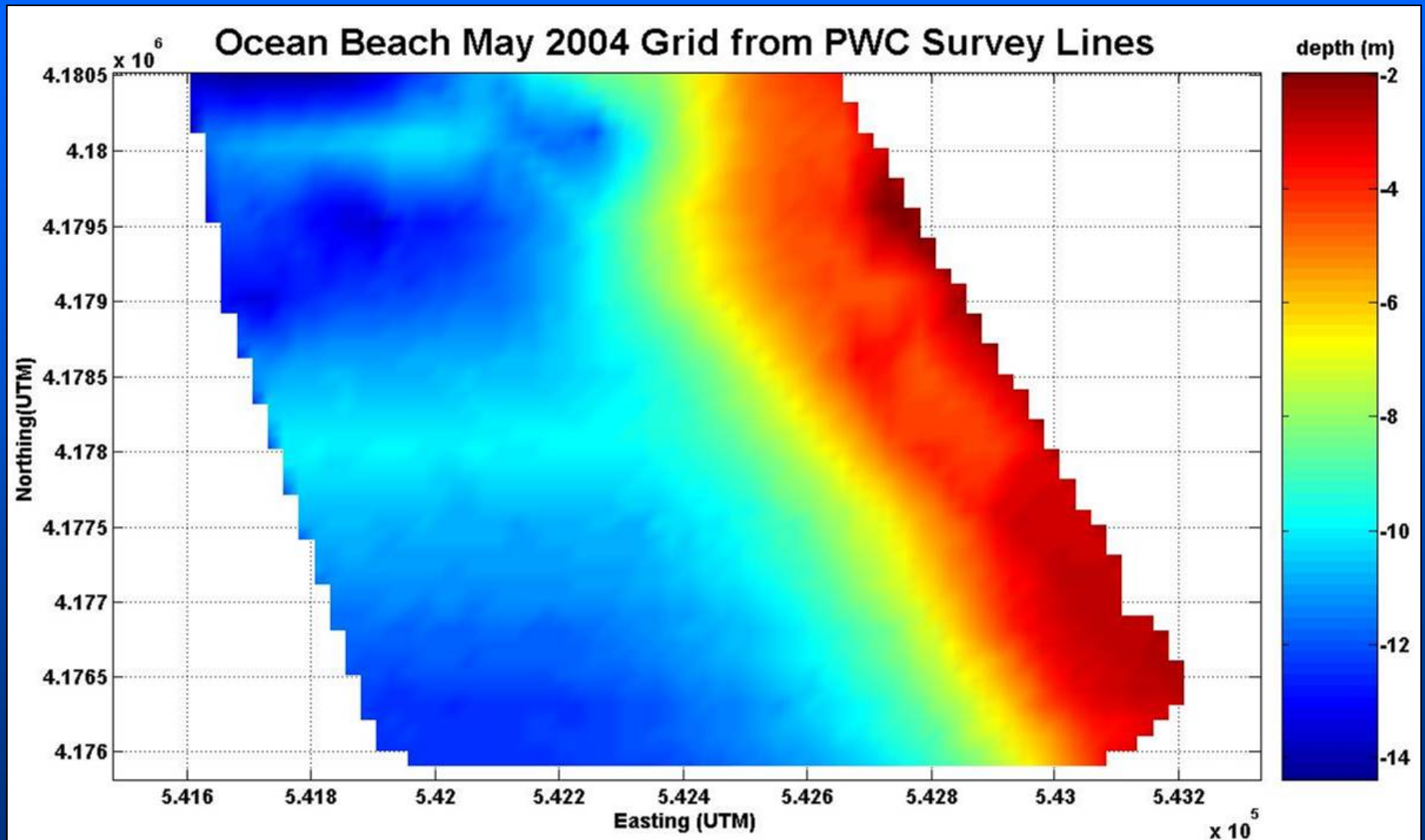




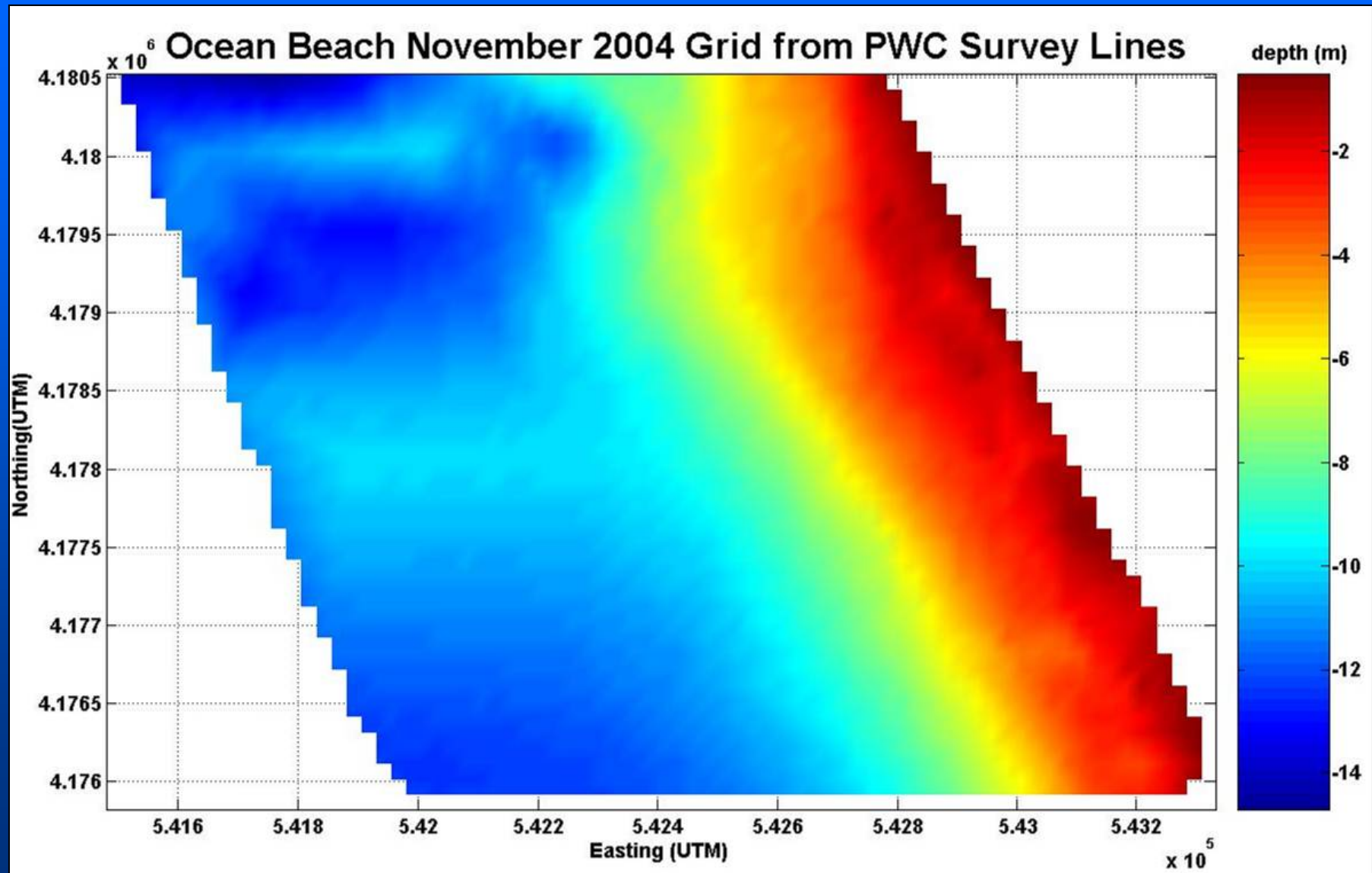
# Nearshore Bathymetry



# Nearshore Bathymetry

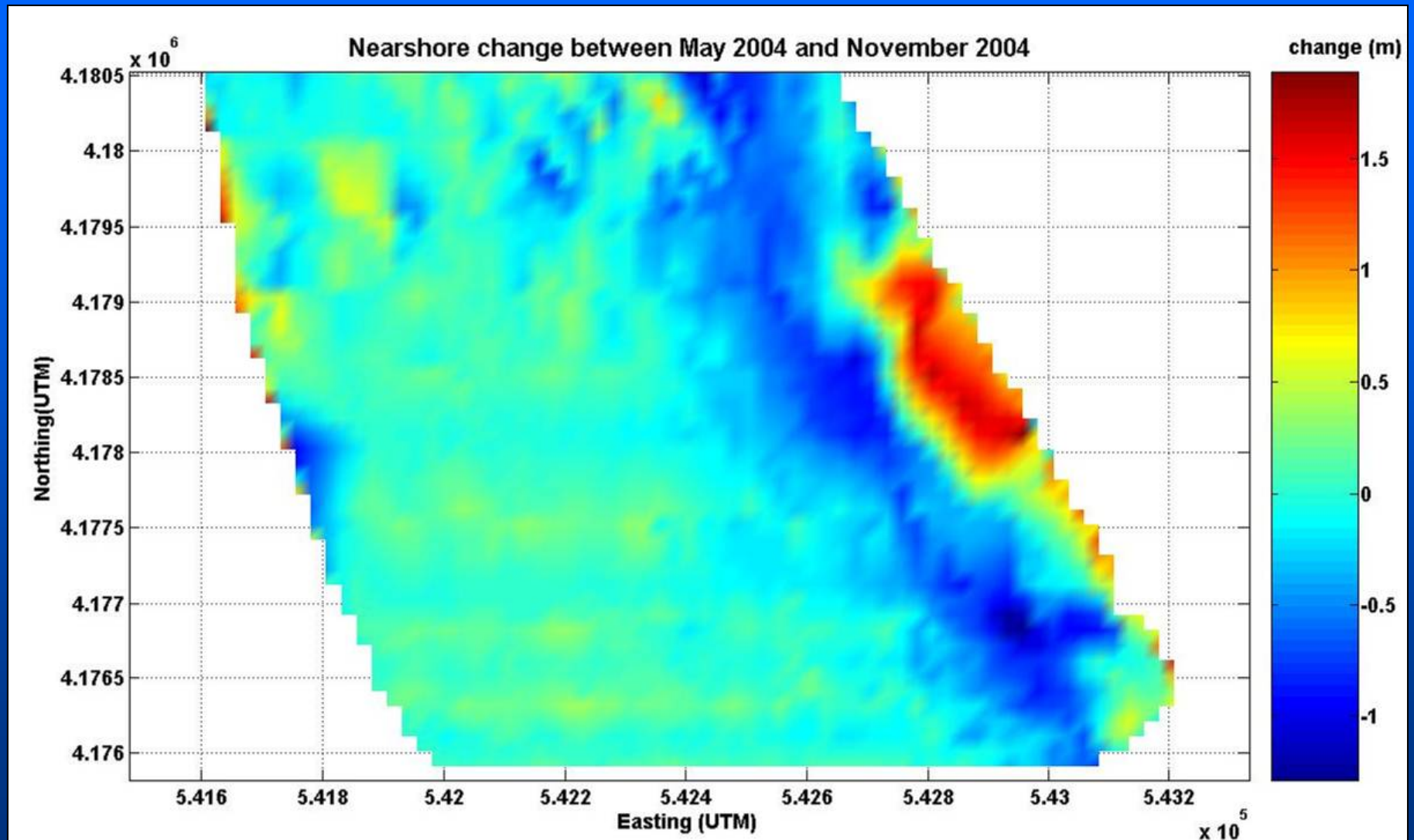


# Nearshore Bathymetry

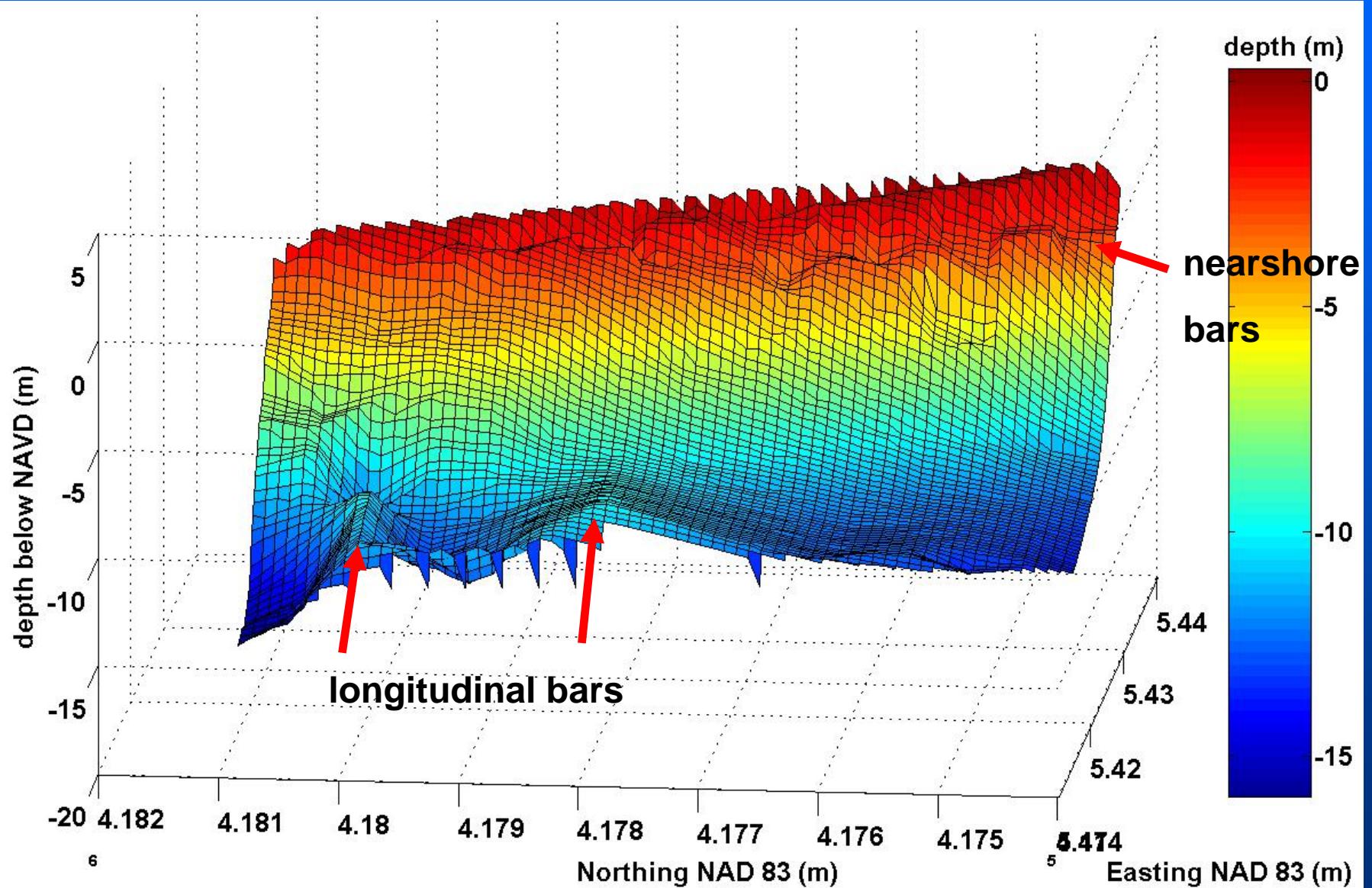




# Seasonal Change

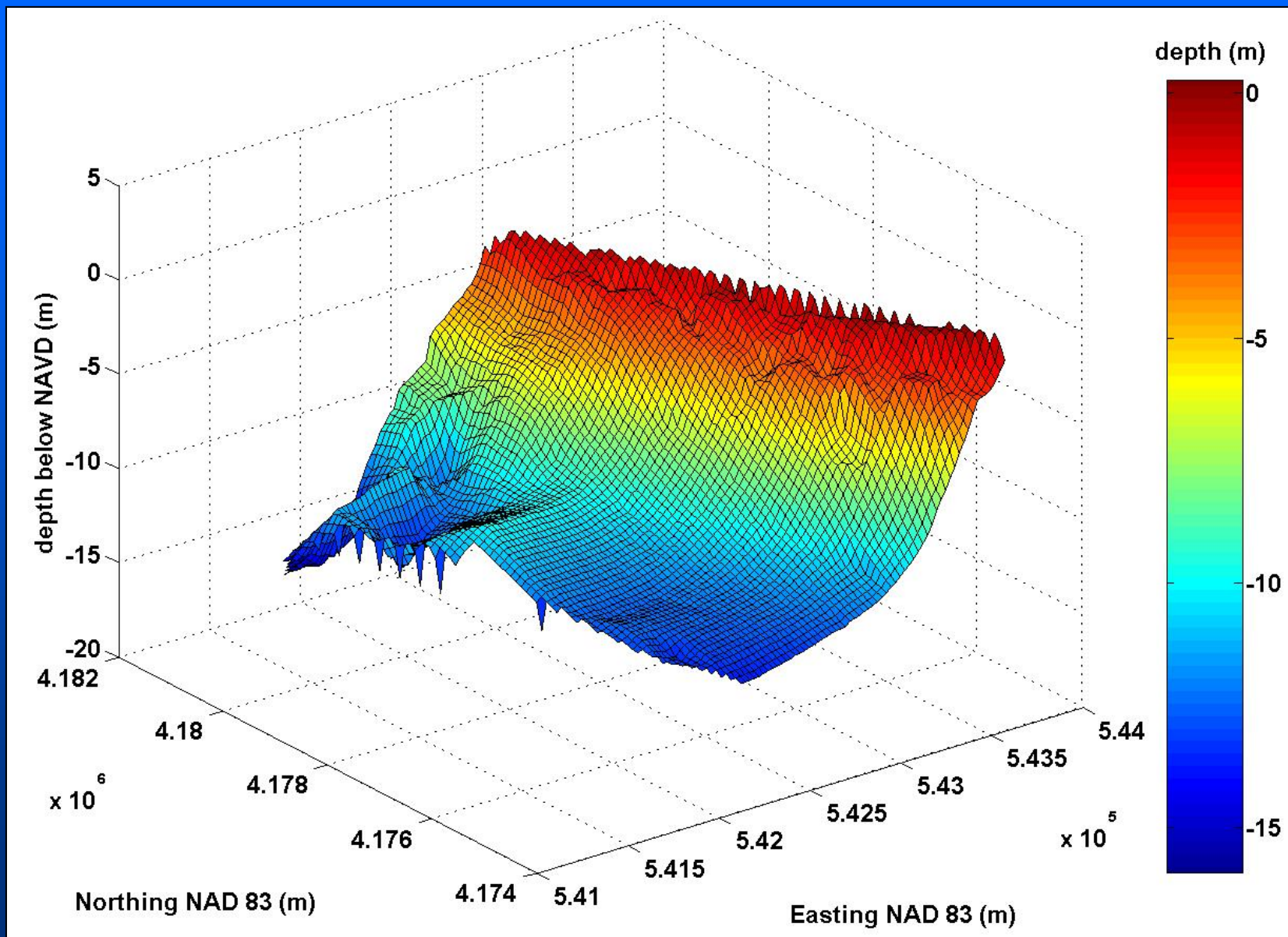


# 3D Nearshore Bathymetry





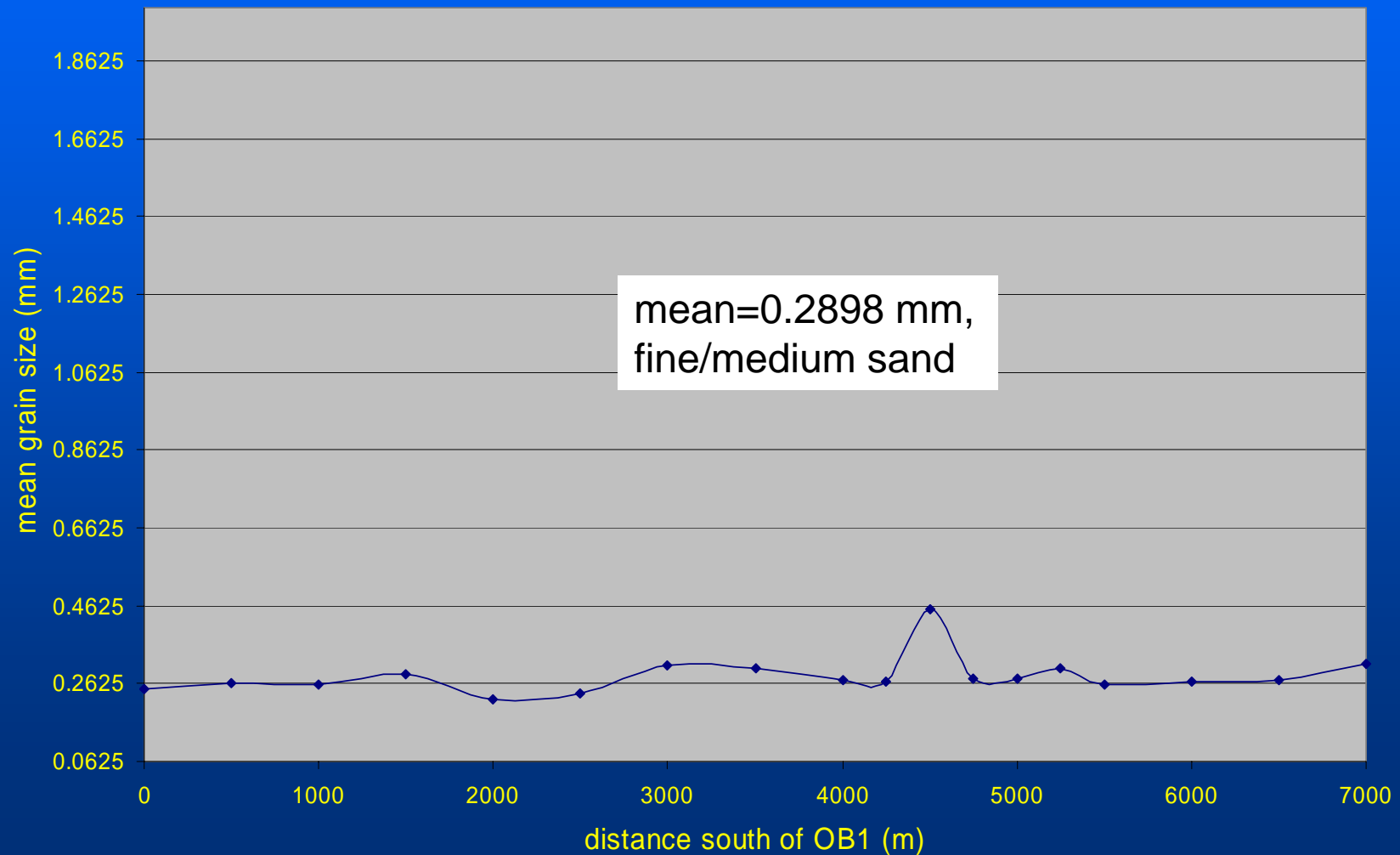
# 3D Nearshore Bathymetry



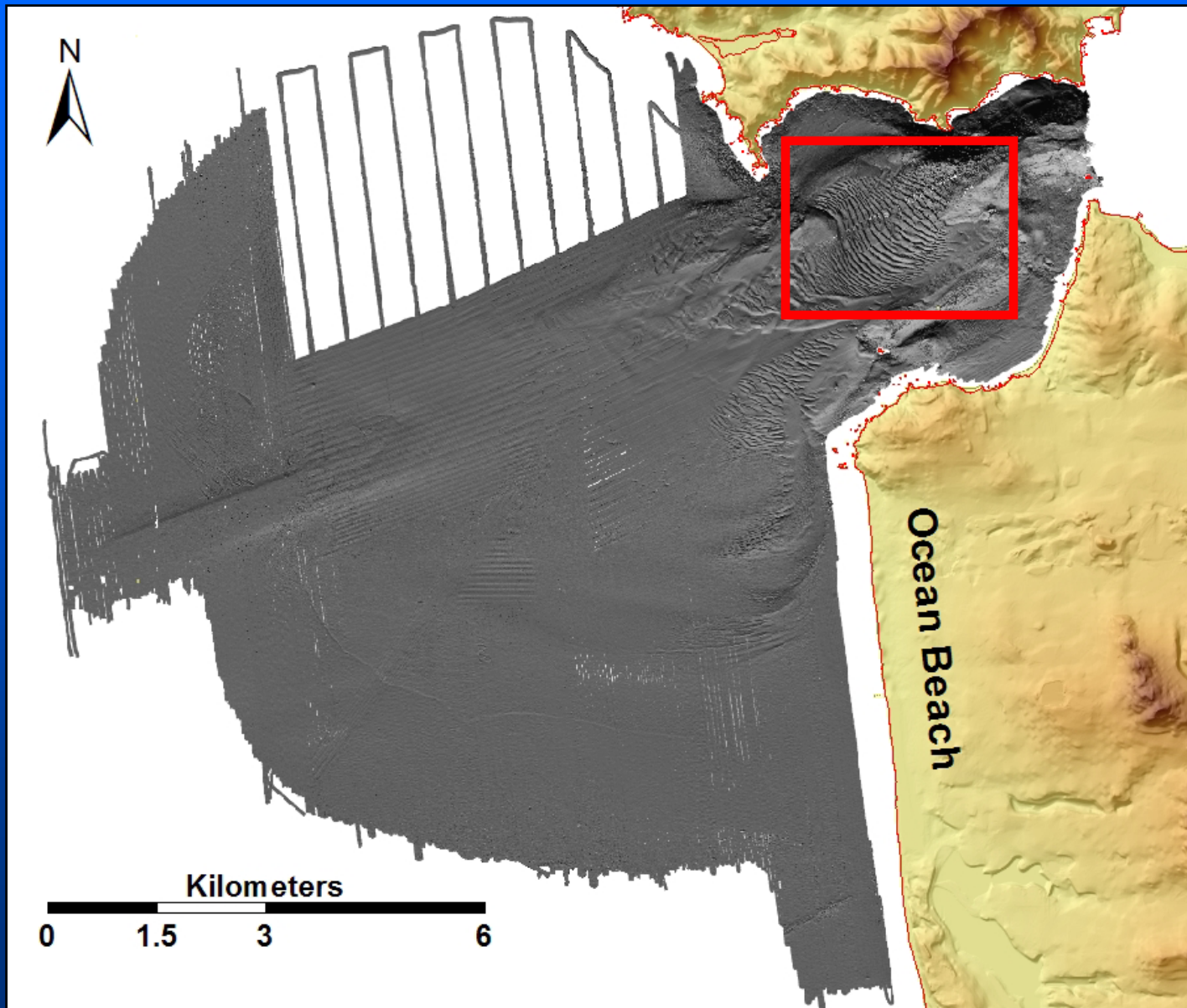


# Sediment Analysis

Mean Grain Size Along Ocean Beach- Swash Samples  
measured from settling tube, May 7, 2004 survey

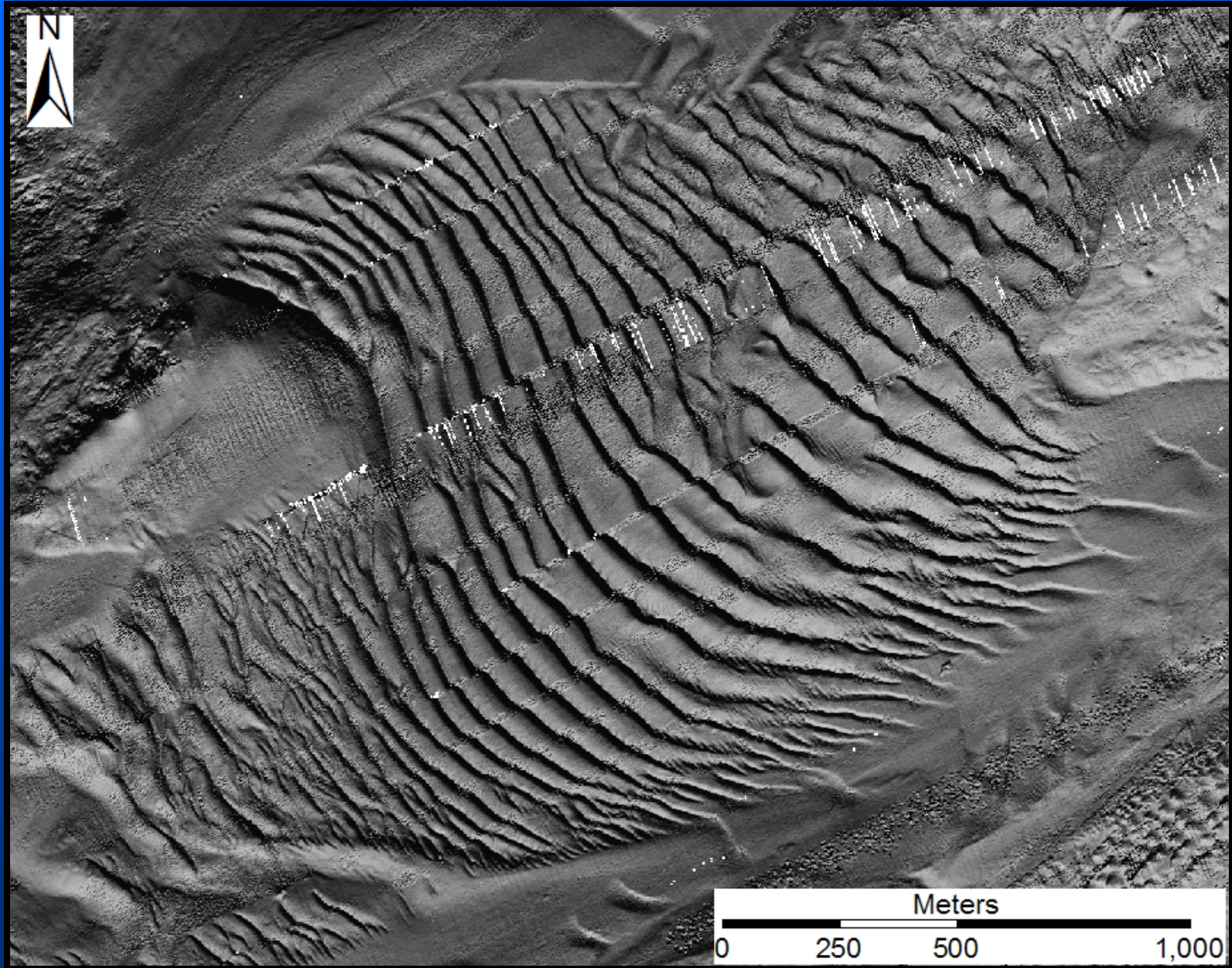


# Multibeam Survey- October 2004



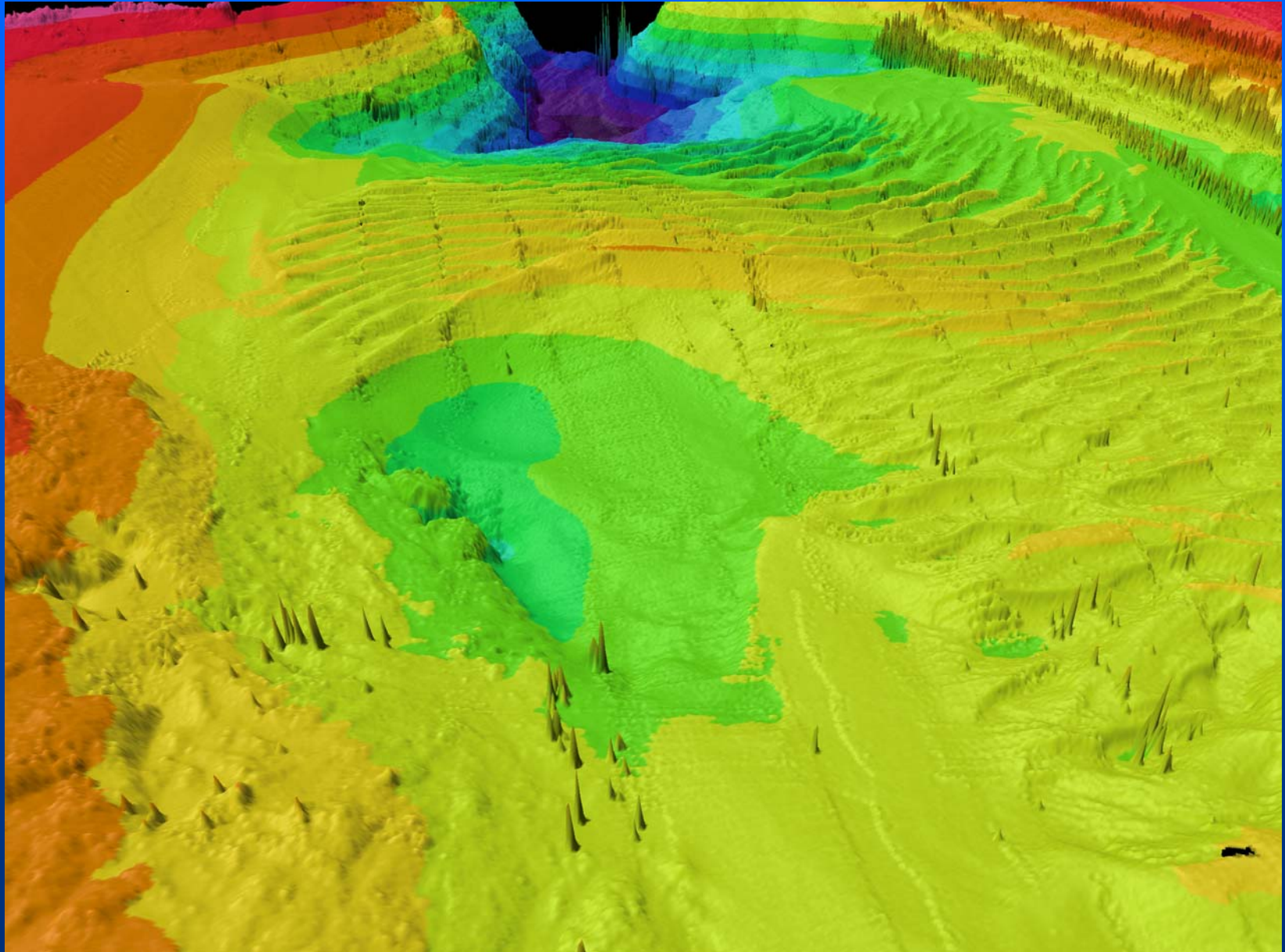


# Bedforms at the mouth of SF Bay

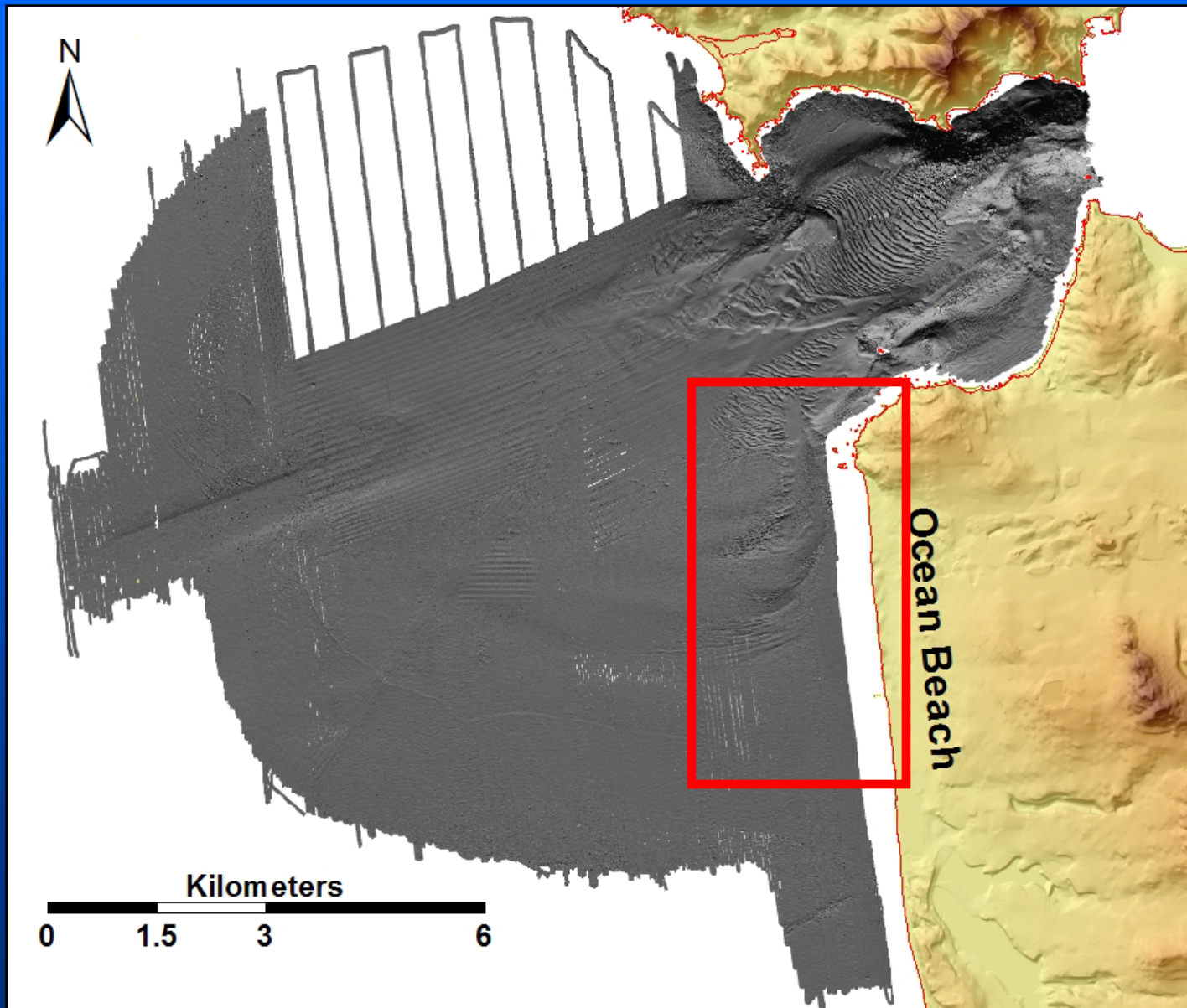




## 3-D Views-SF mouth

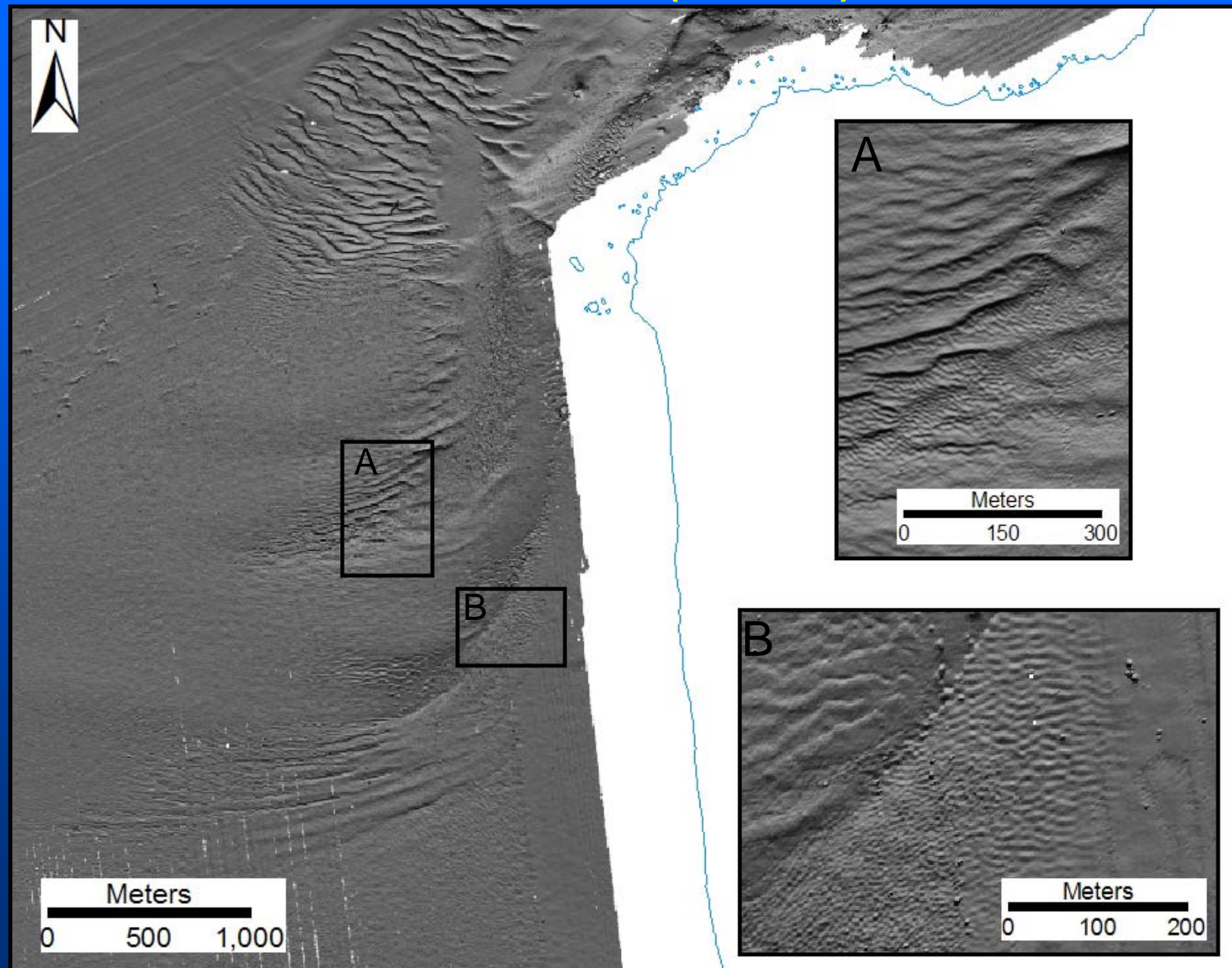


# Multibeam Survey



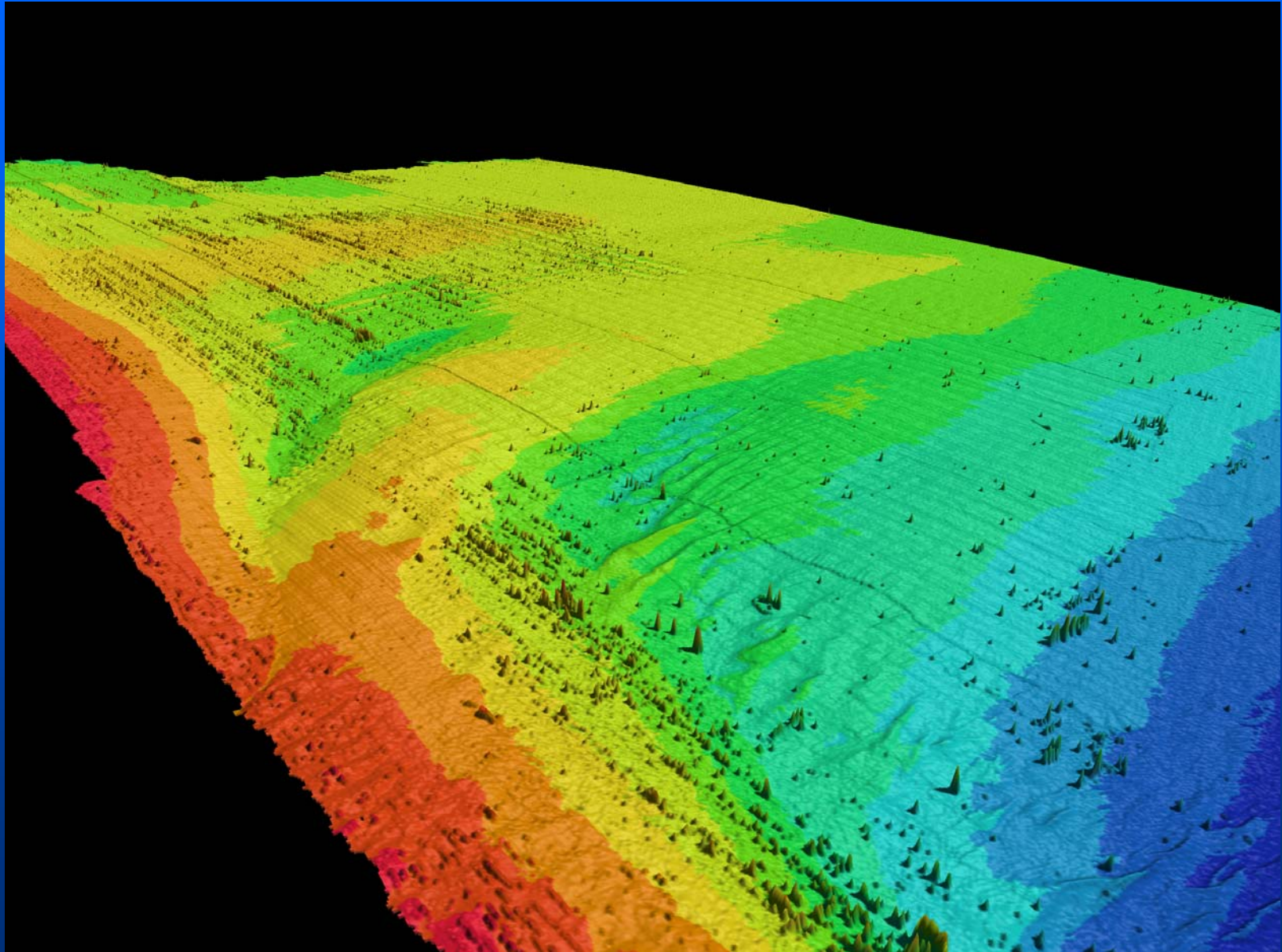


# Bedforms (cont.)

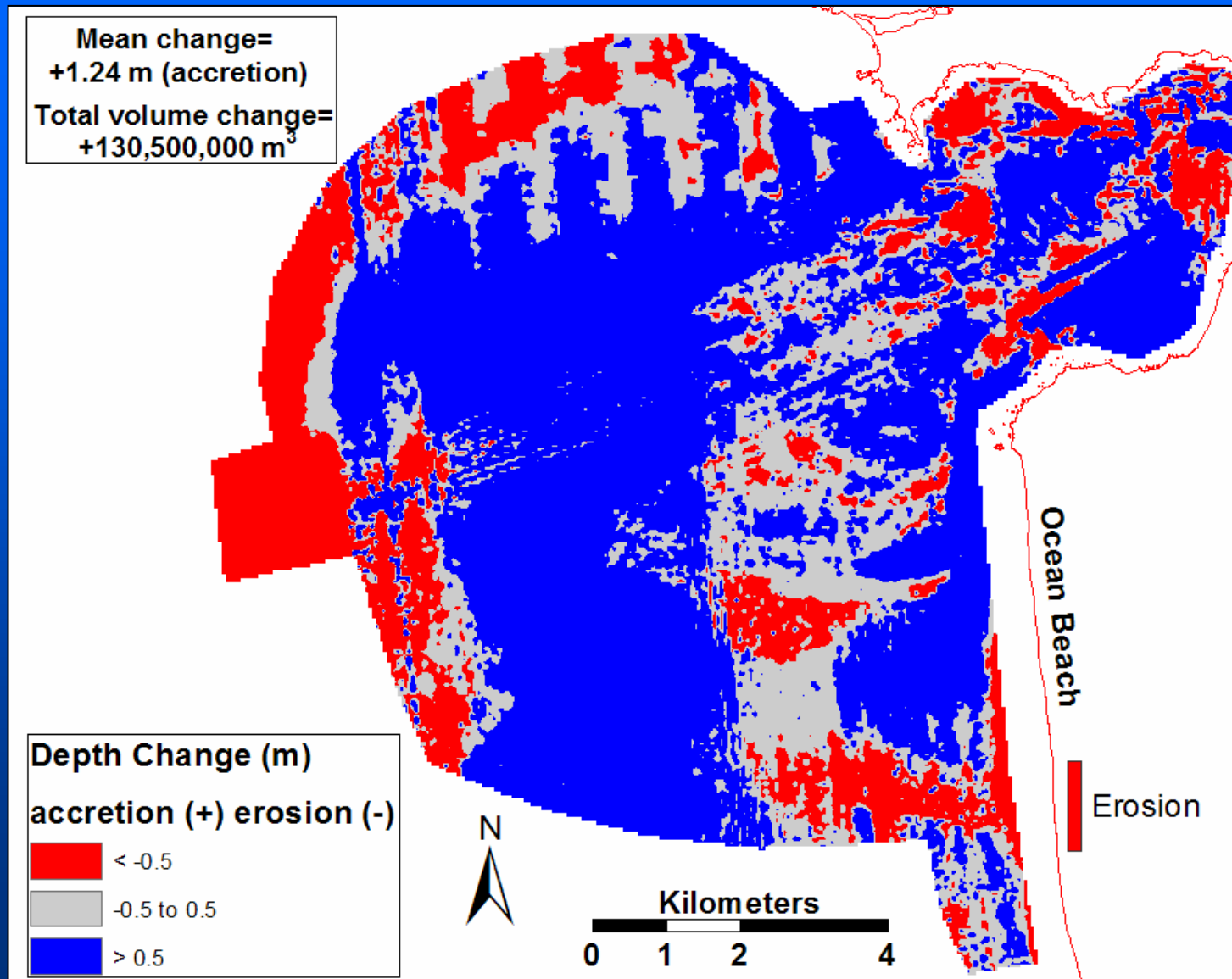




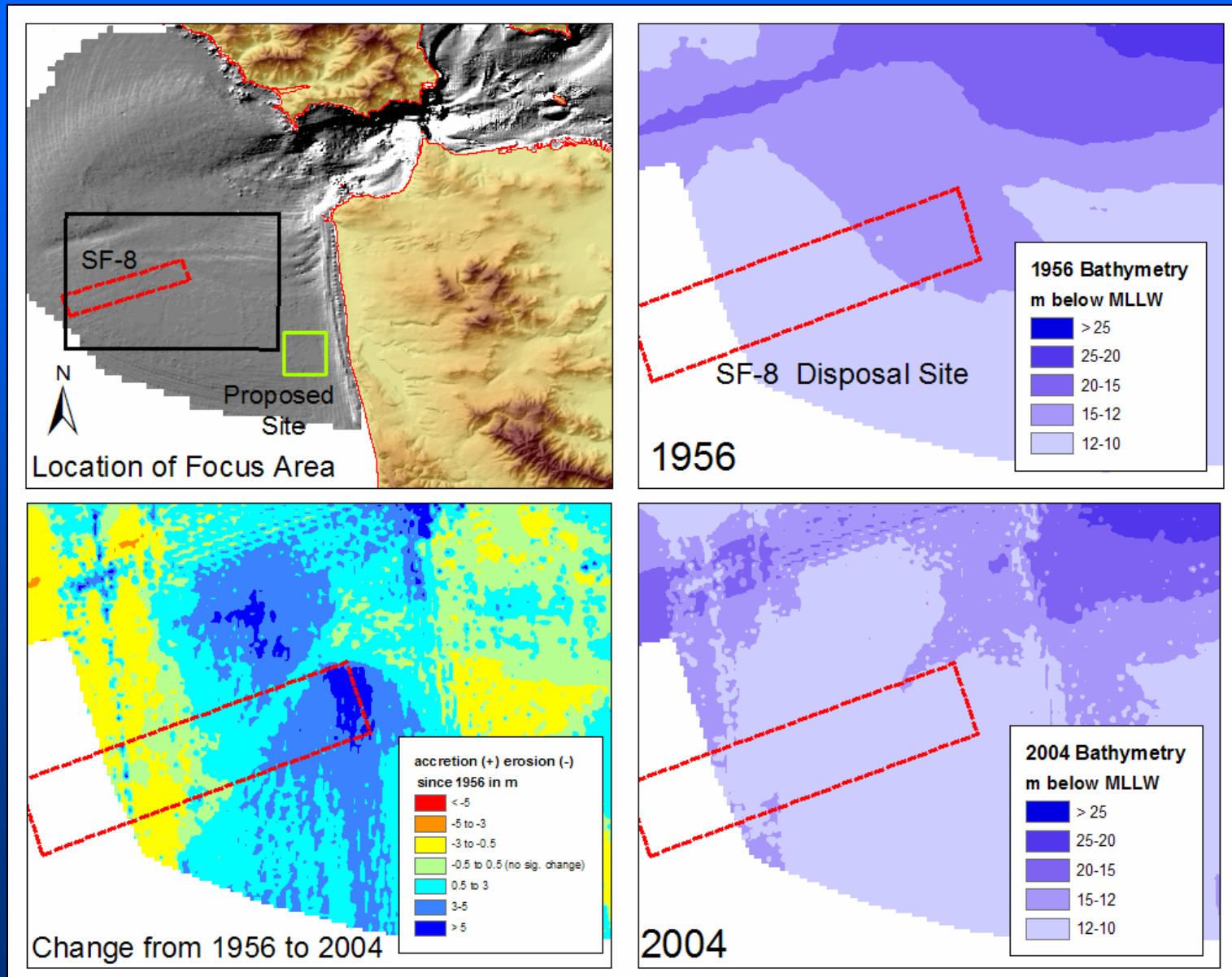
# 3-D Views- Ocean Beach



# Comparison w/ 1956 Bathymetry



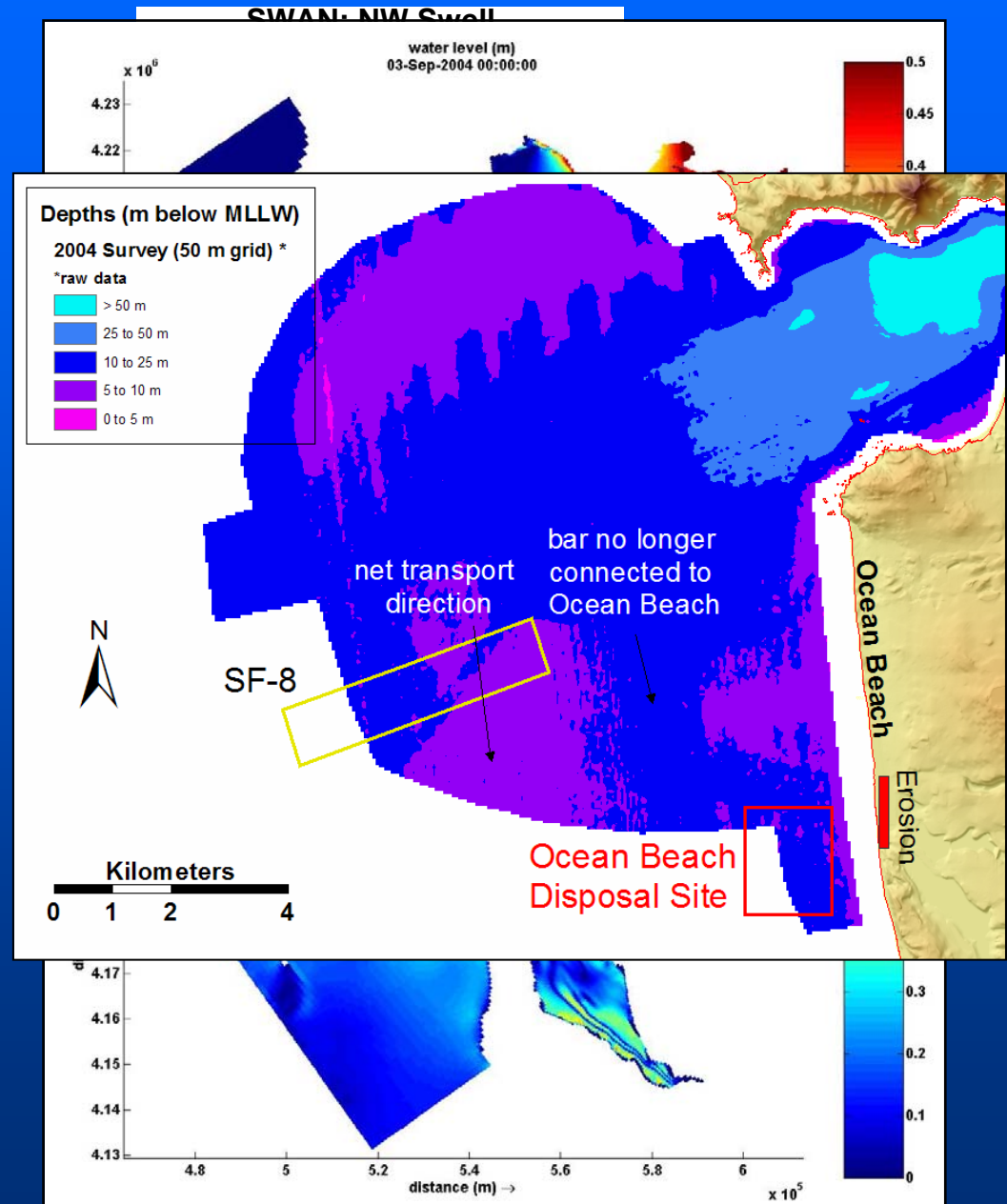
# Comparison w/ 1956 Bathymetry





# Role of Modeling

- Analyze wave refraction, tidal current and sedimentation patterns due to evolving bathymetry, bay development, sediment supply and wave climate
- Test coastal response to variations in delta discharge, winds, wave direction, storms, etc.
- Evaluate sediment management options
- Predict long-term coastal geomorphic change

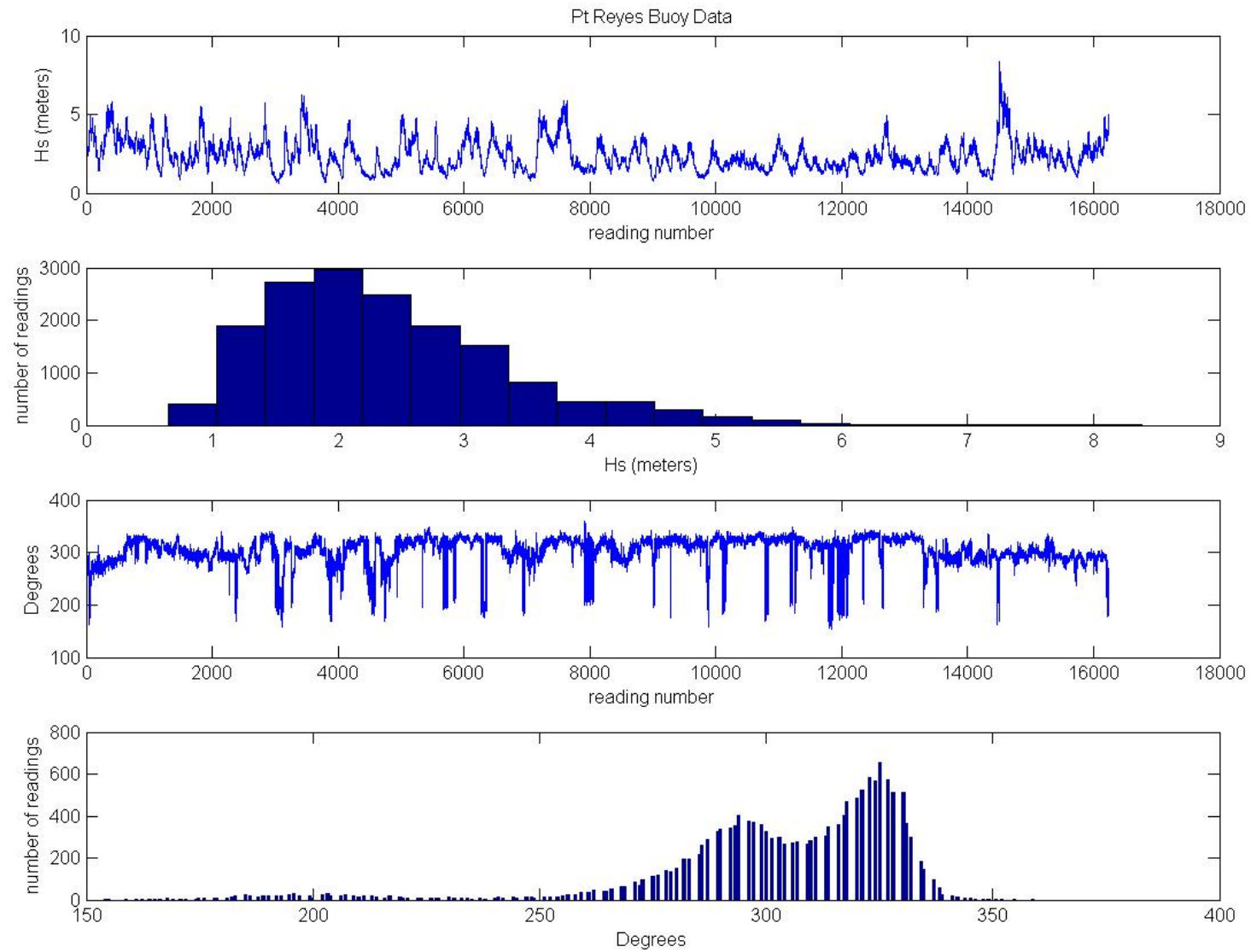


# Recent Wave Climate

## PT. REYES WAVE BUOY SUMMARY

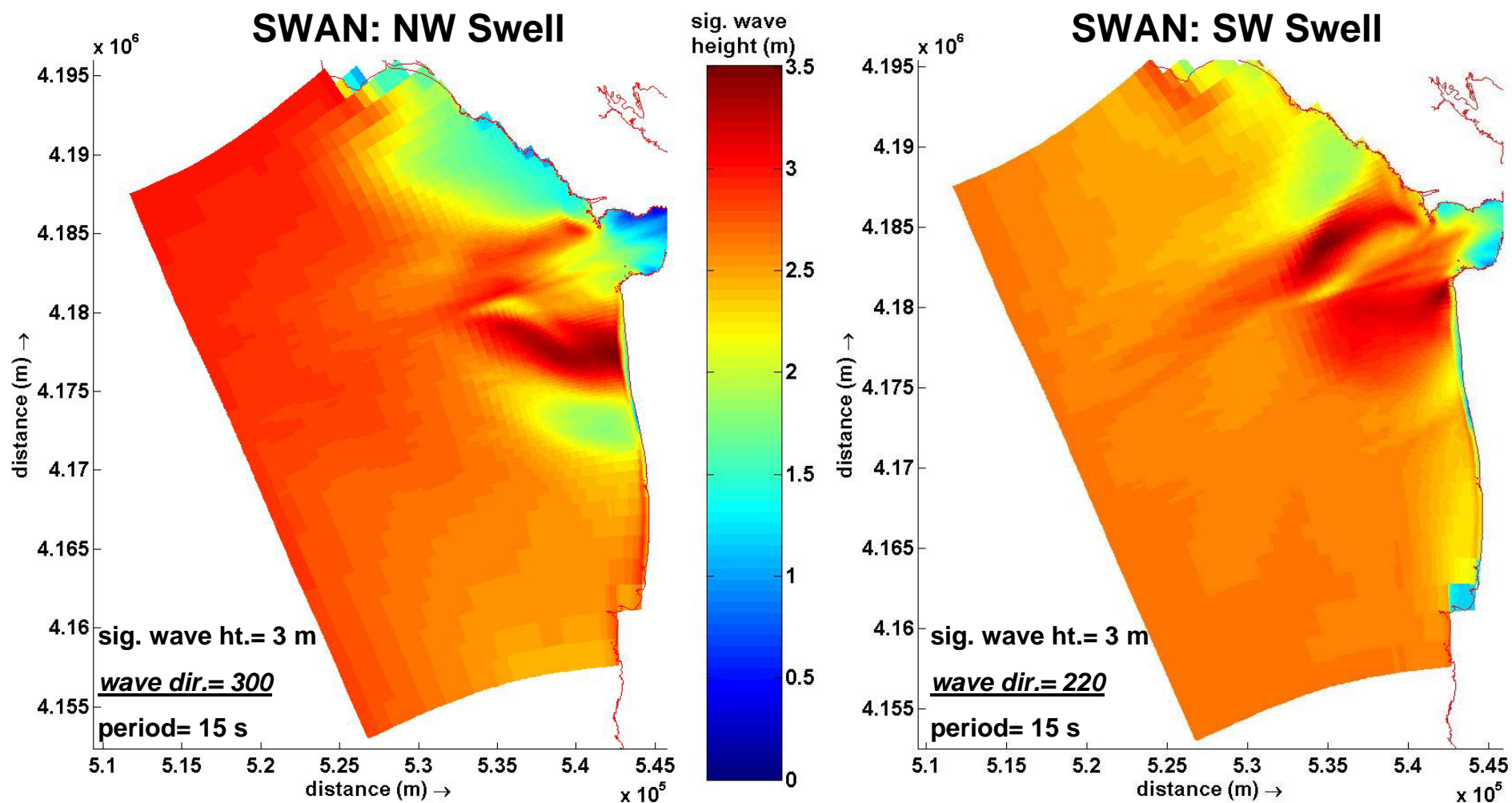
<u>Year</u>	<u>Max Hs</u>	<u>Avg Hs</u>	<u>Avg deg</u>	<u>Avg Tp</u>
1997	6.9	2.4	290.1	10.8
1998	8.2	2.7	295.9	11.1
1999	8.2	2.6	299.2	11.1
2000	7.9	2.5	295.9	11.1
2001	8.4	2.6	298.4	10.8
2002	8.4	2.4	303.0	10.6
2003	6.7	2.3	291.4	11.0
2004	<u>7.3</u>	<u>2.2</u>	<u>297.7</u>	<u>10.1</u>
<b>Average</b>	<b>7.7</b>	<b>2.5</b>	<b>296.5</b>	<b>10.8</b>

# Wave Statistics-1982

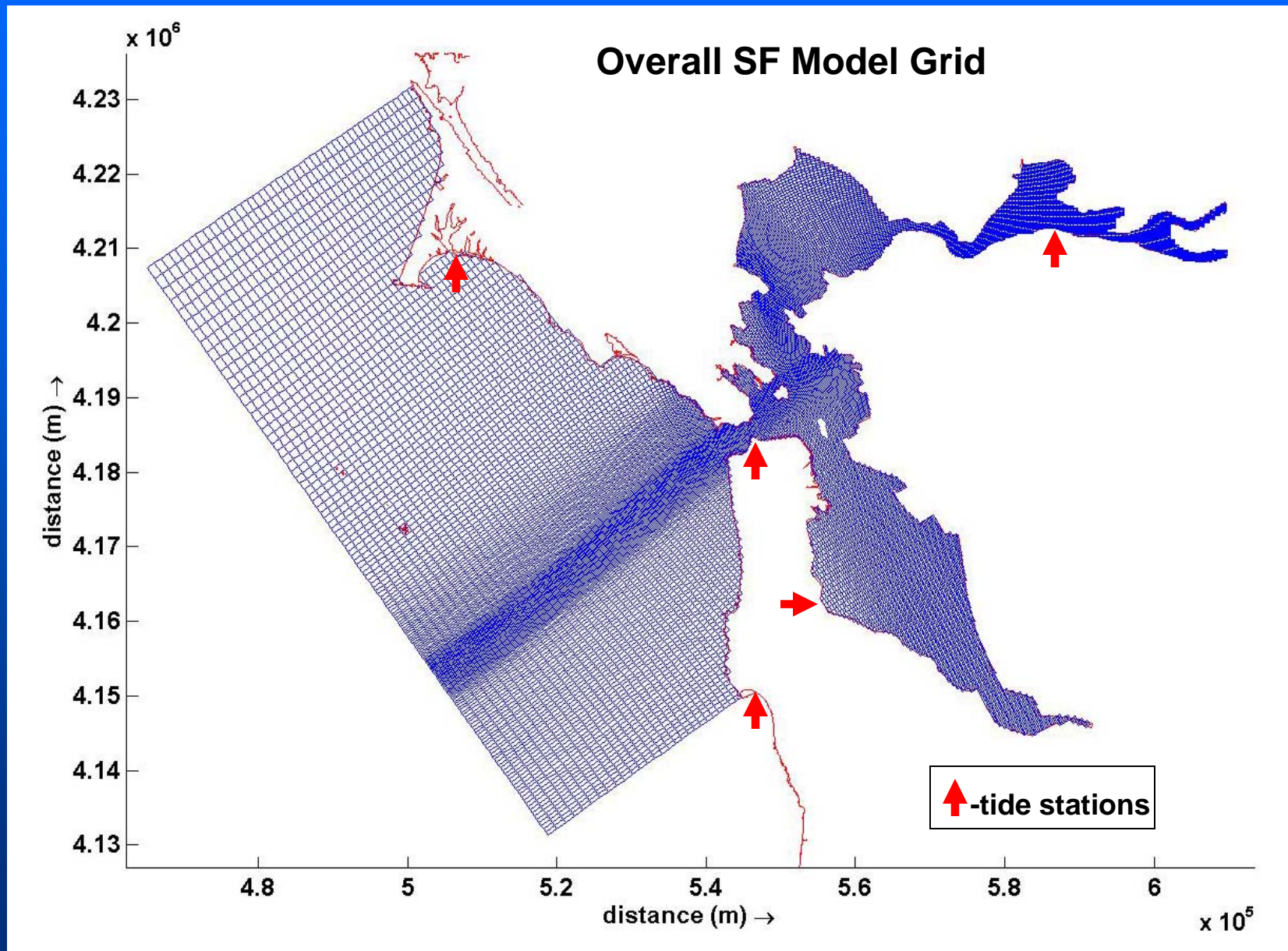




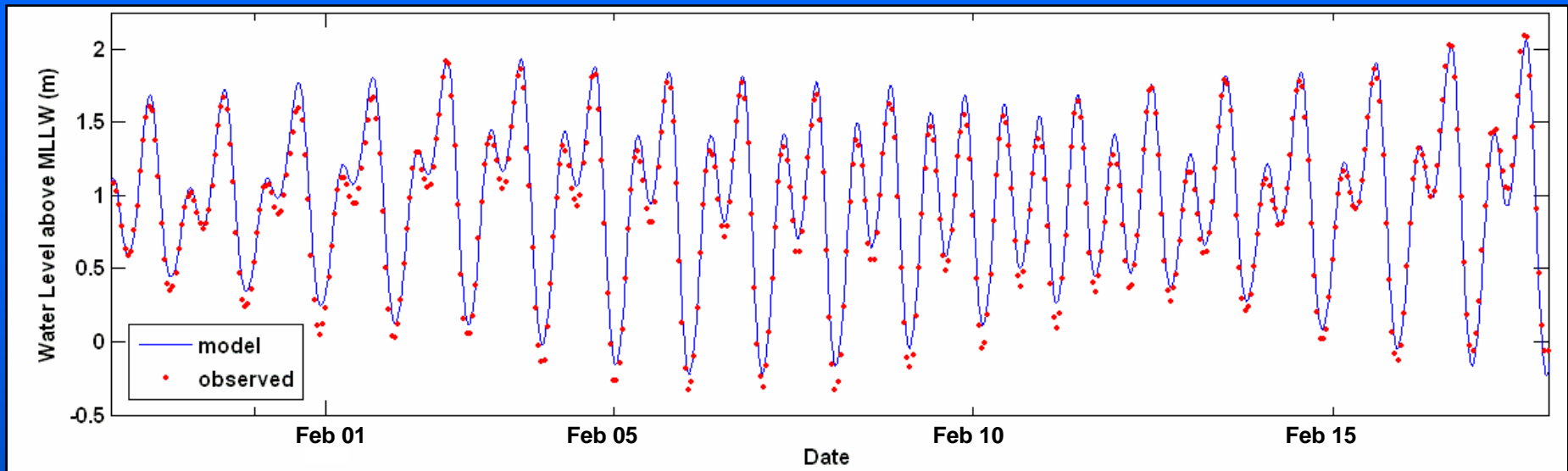
# Wave Modeling



# Numerical Modeling



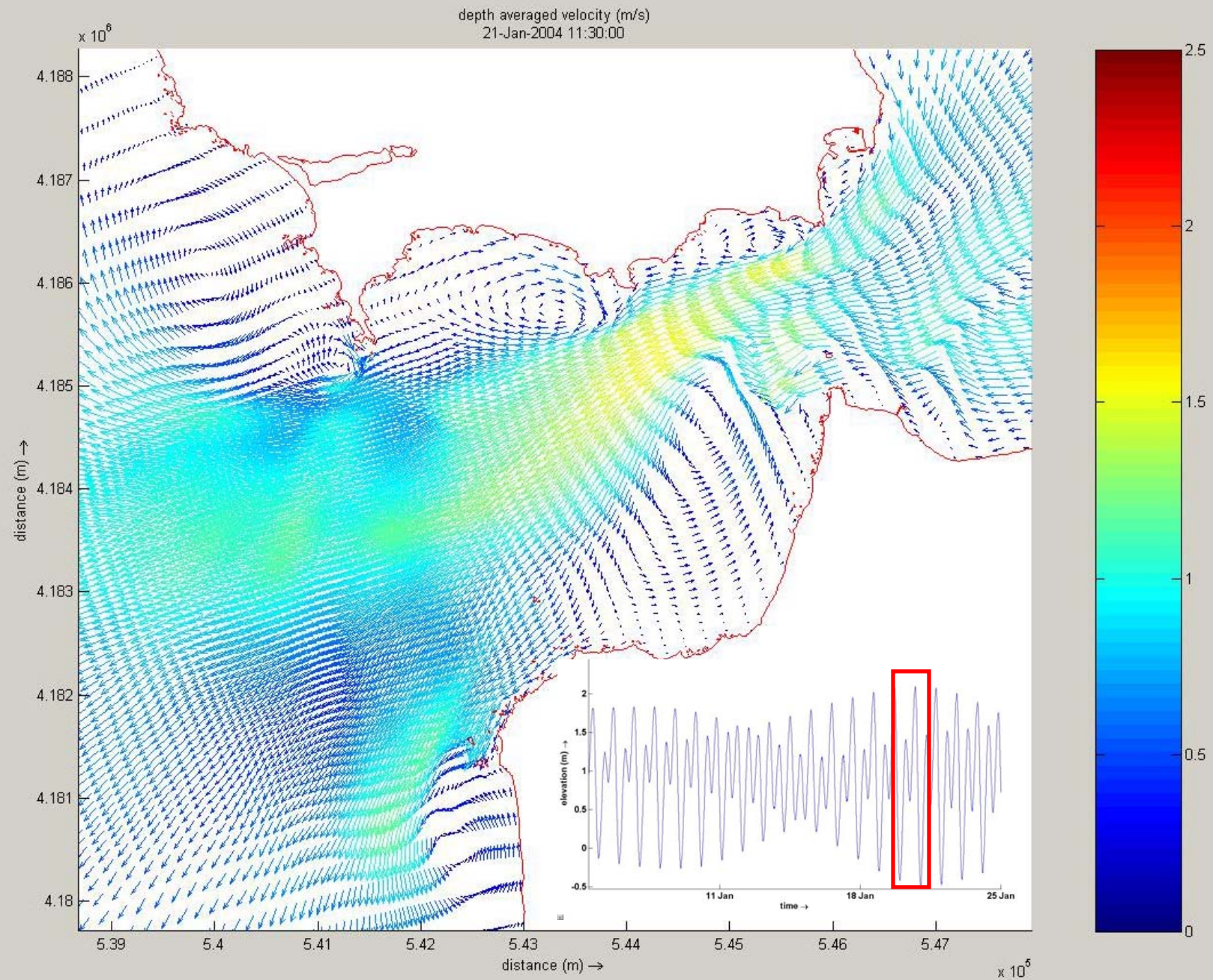
# Water Level Validation



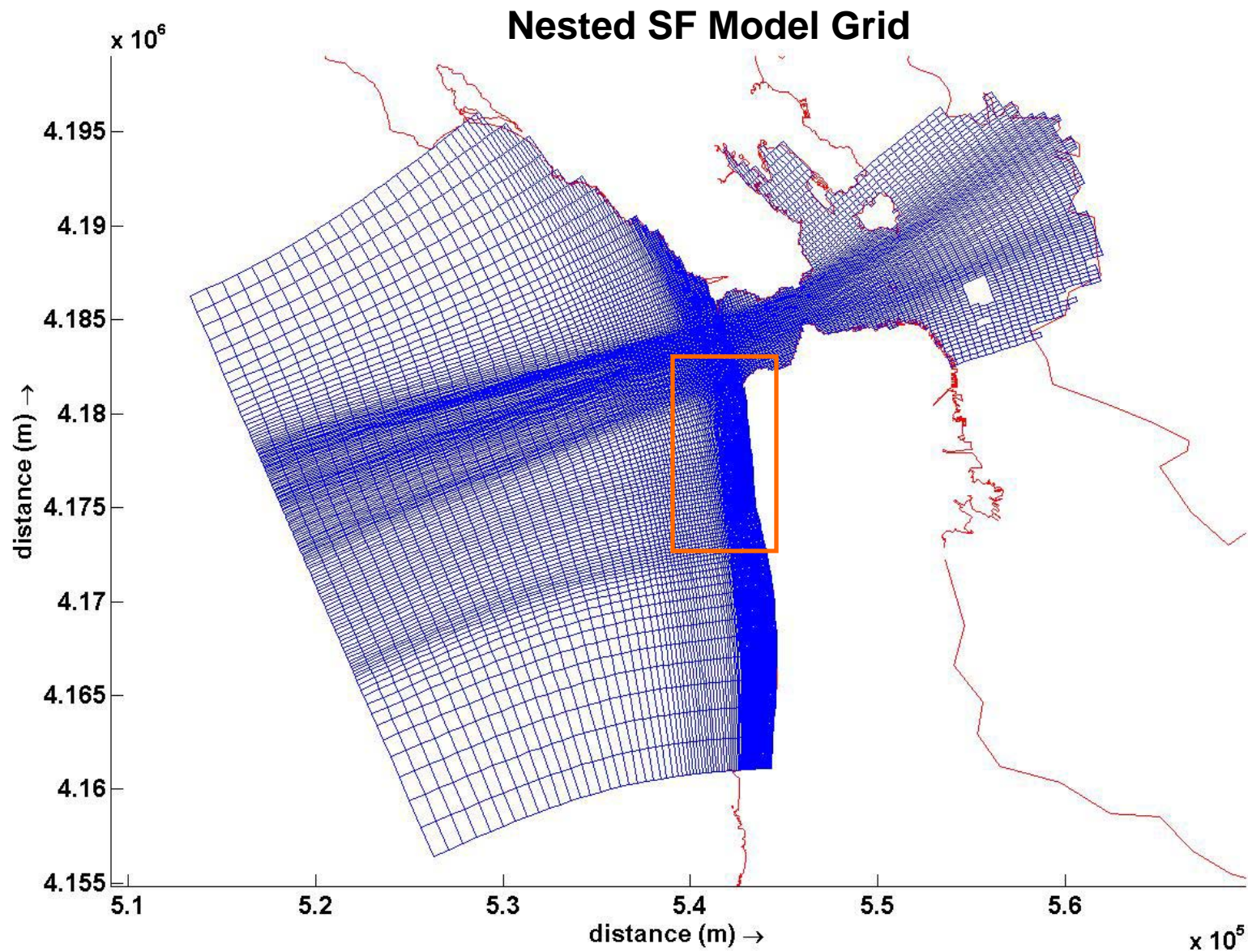
tidal constituents	observed amplitude (m)	modeled amplitude (m)	amplitude error	observed phase (deg)	modeled phase (deg)	phase error
Q1	0.038	0.038	0.994	193.831	193.197	-0.634
O1	0.225	0.224	0.997	207.458	207.690	0.231
P1	0.118	0.118	0.998	228.906	229.278	0.372
K1	0.375	0.374	0.998	225.706	226.078	0.372
N2	0.115	0.115	0.997	172.881	172.858	-0.023
M2	0.565	0.564	0.999	207.140	207.297	0.157
S2	0.161	0.161	0.998	217.015	216.885	-0.130
K2	0.047	0.047	0.998	225.515	225.385	-0.130



# Mouth of SF Bay Tidal Currents

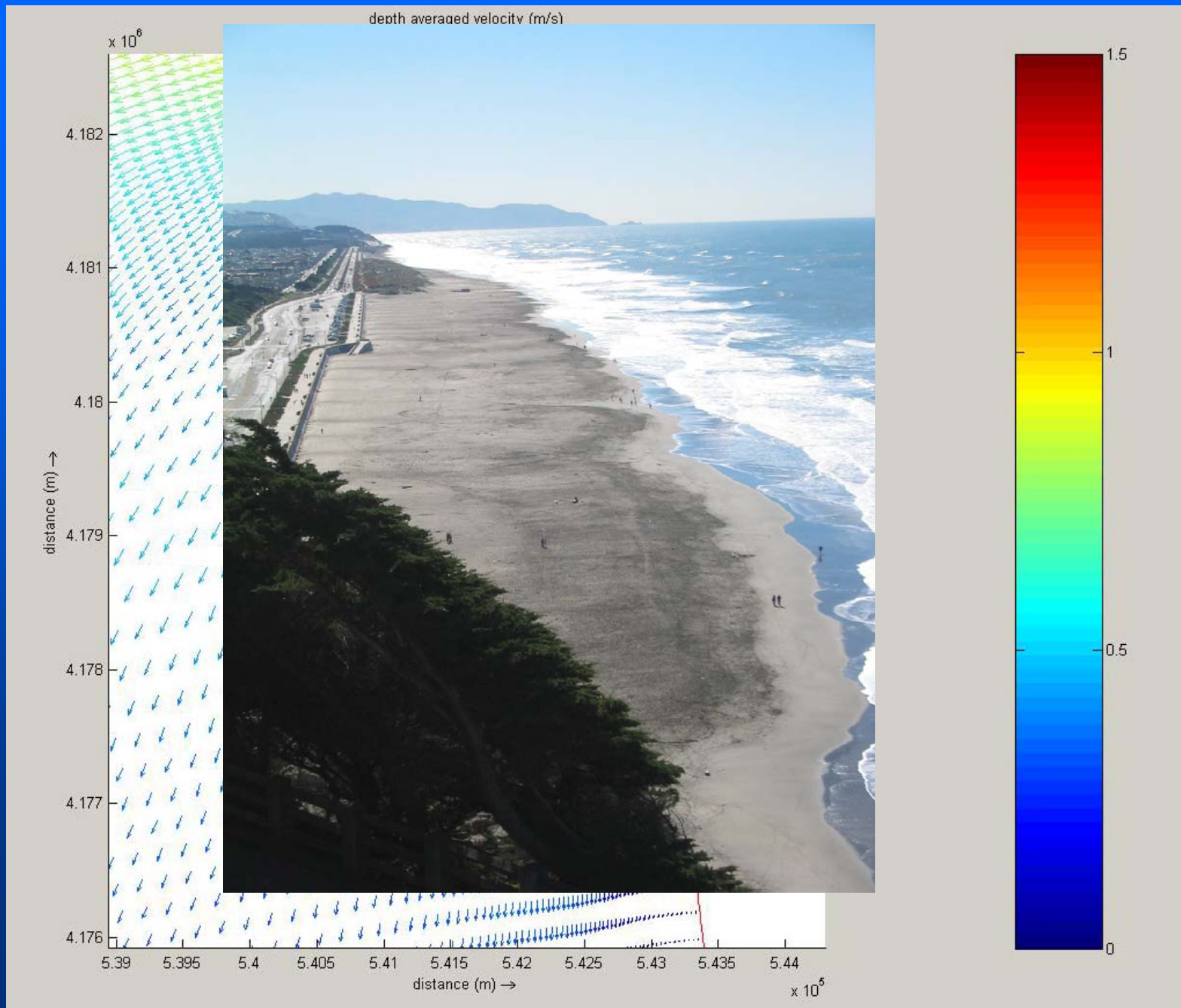


# Numerical Modeling



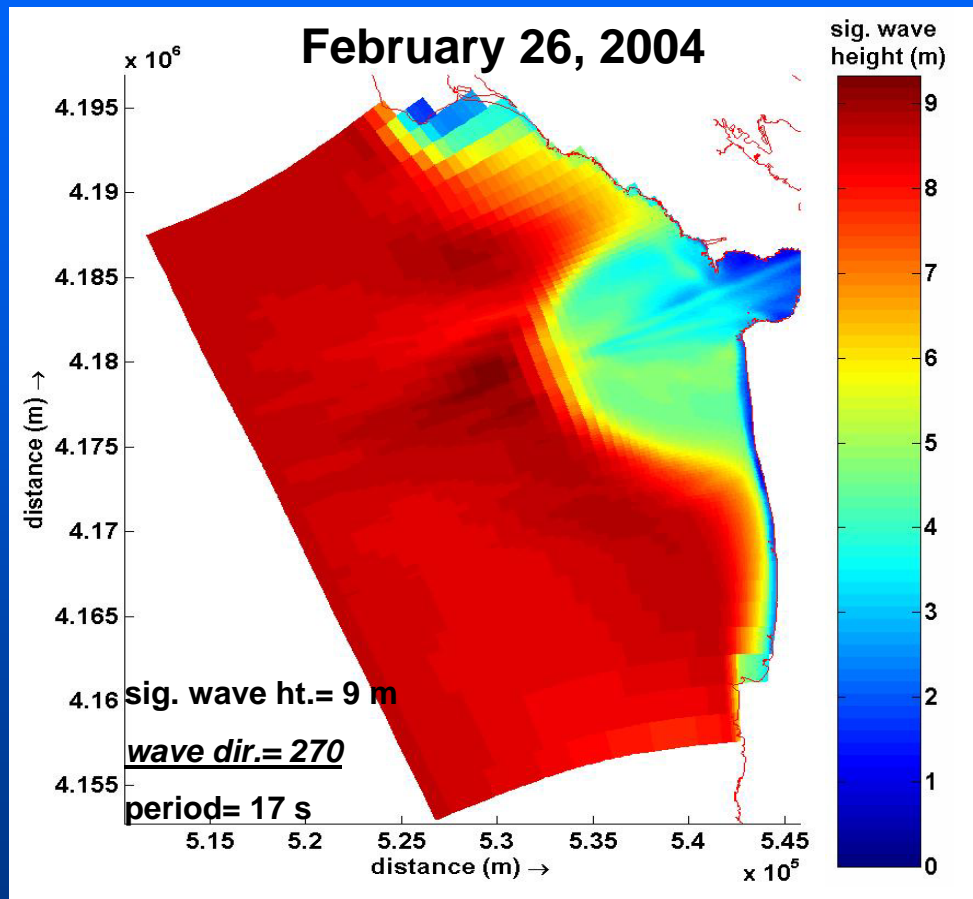


# Ocean Beach Tidal Currents



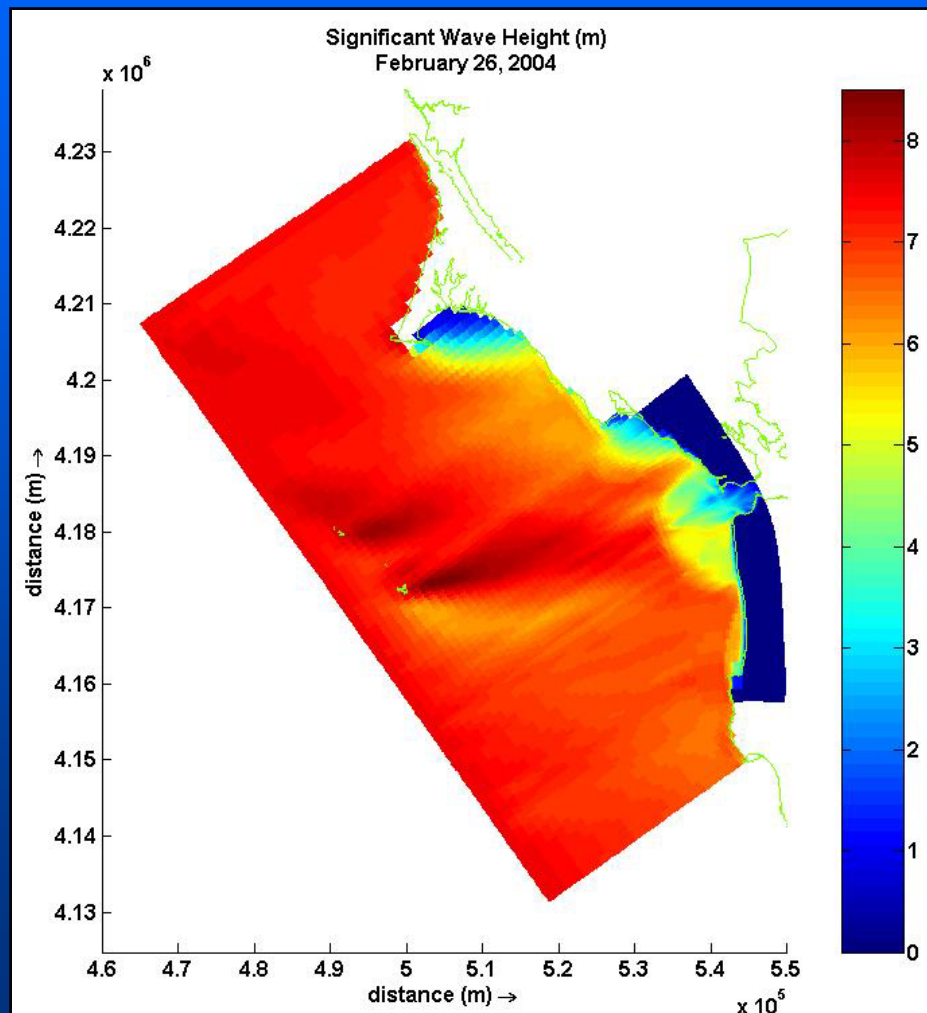


# Extreme Events

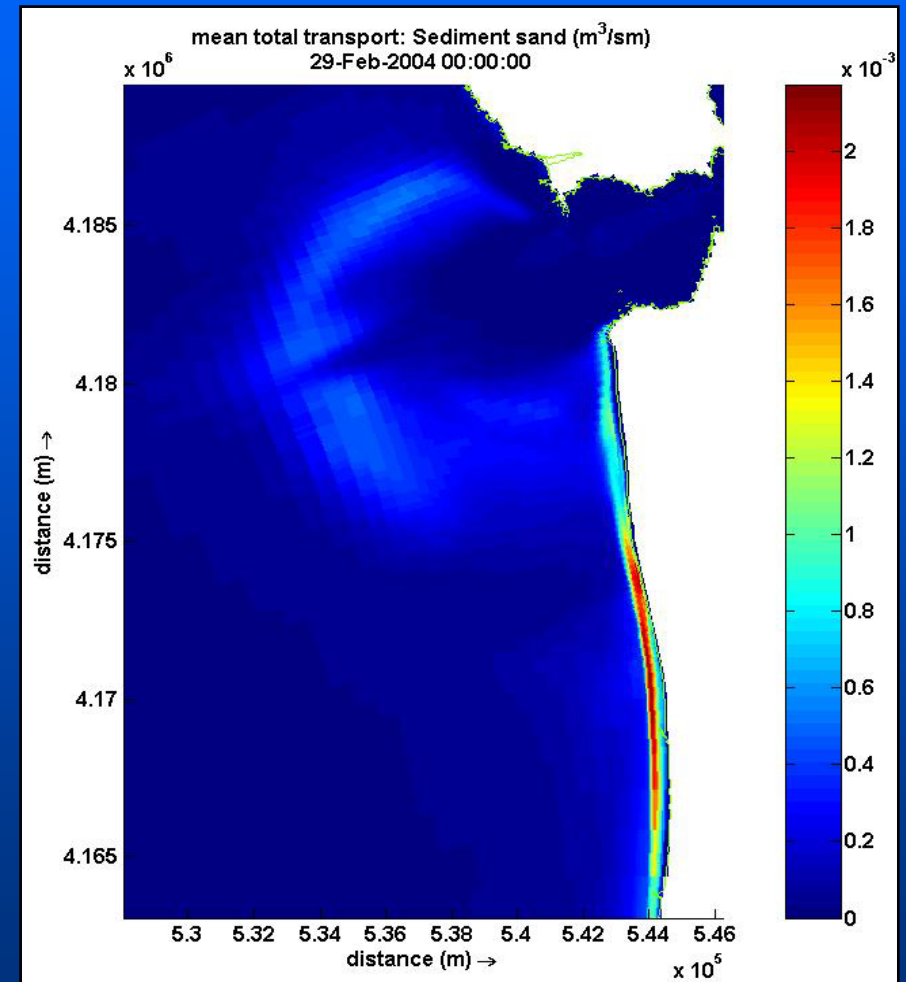


# Modeling Extreme Events

## Storm Wave Patterns

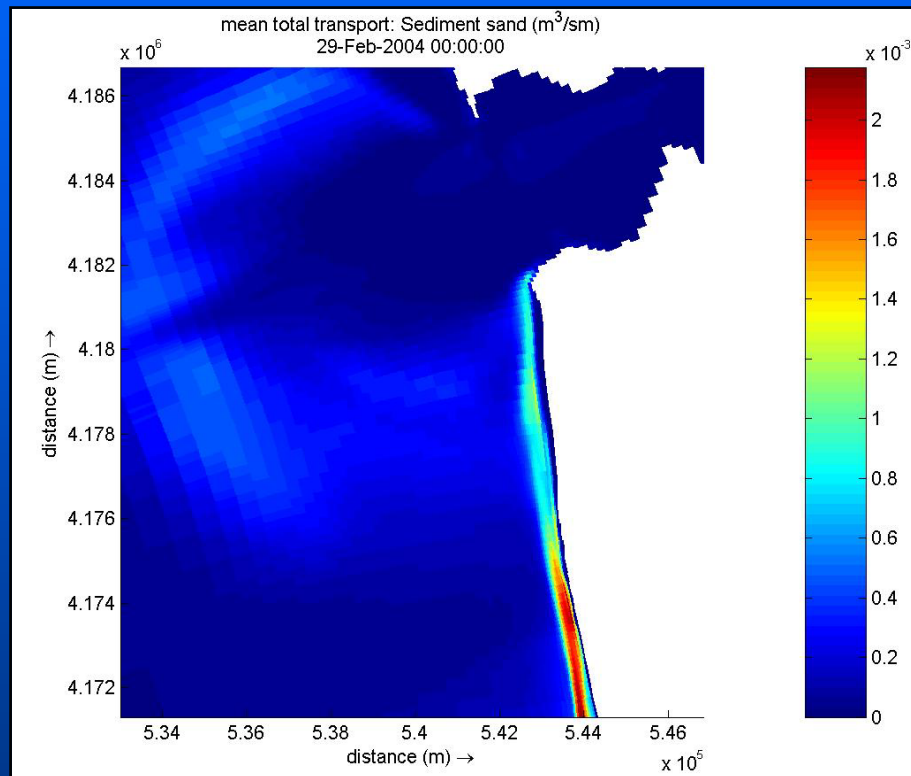


## Storm Sediment Transport

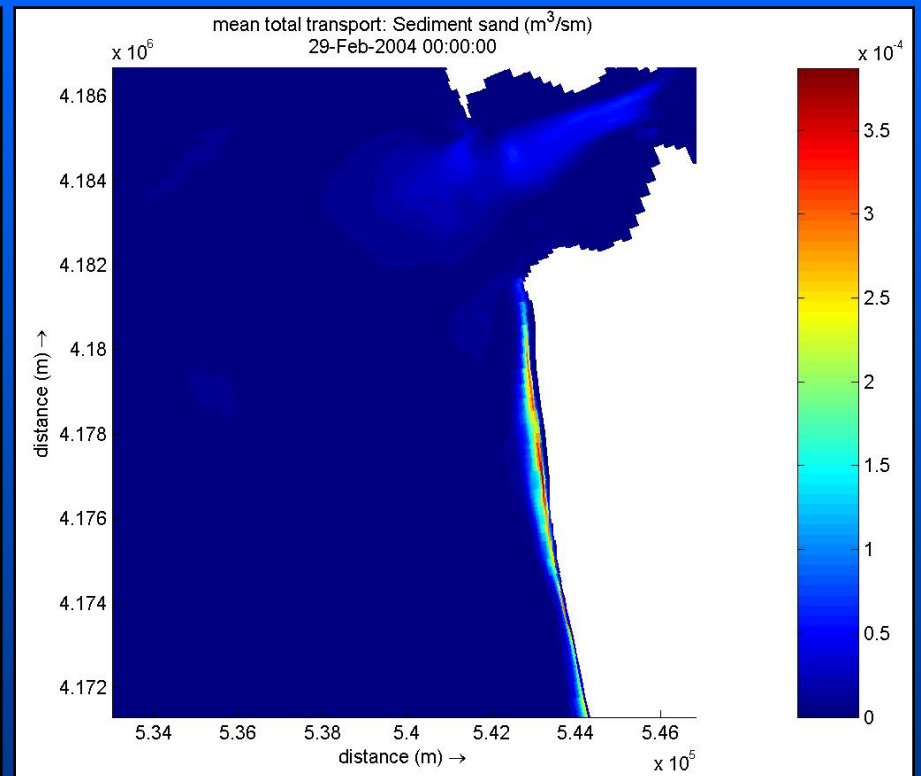


# Modeling Extreme Events

## Storm Sediment Transport



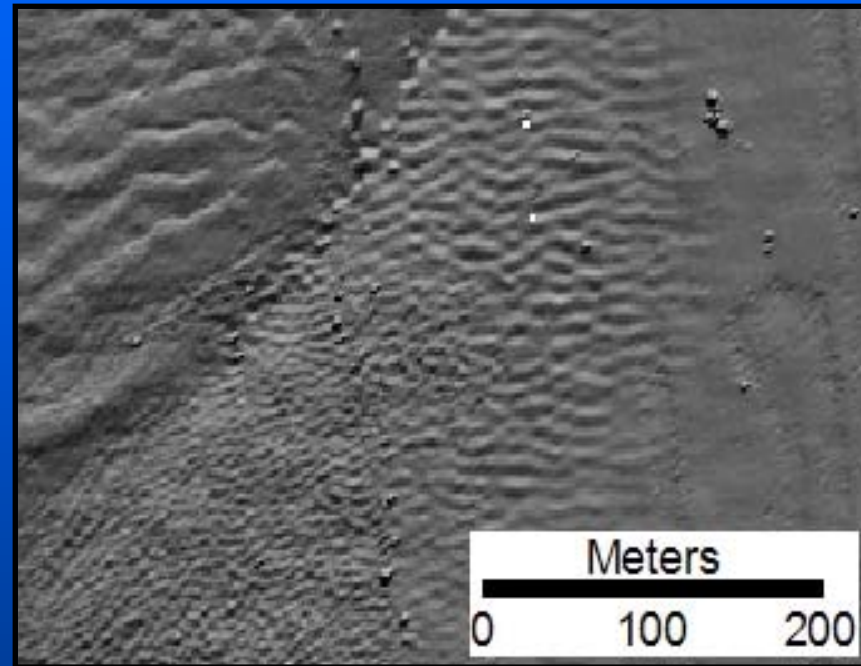
## Typical Sediment Transport





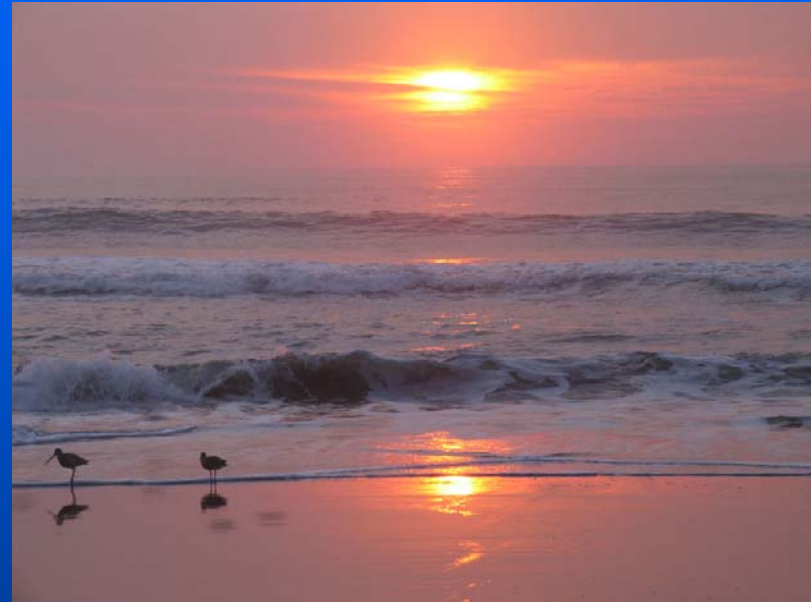
# Key Findings

- Sediment abundant-supply not the issue
- Ebb tidal delta and nearshore morphology of Ocean Beach are strongly coupled- wave refraction, sediment transport, flow structure
- Bedforms on many scales and orientations attest to dynamic tidal inlet environment



# Future Directions

- Modeling of new dredge disposal
- Model validation with open coast in situ measurements in key locations
- Web-based, near-real time coastal observing system
- Storm impact and risk assessment
- Bedform dynamics in high-energy wave and current environment



National Park Service

National Park Service  
U.S. Department of the Interior

